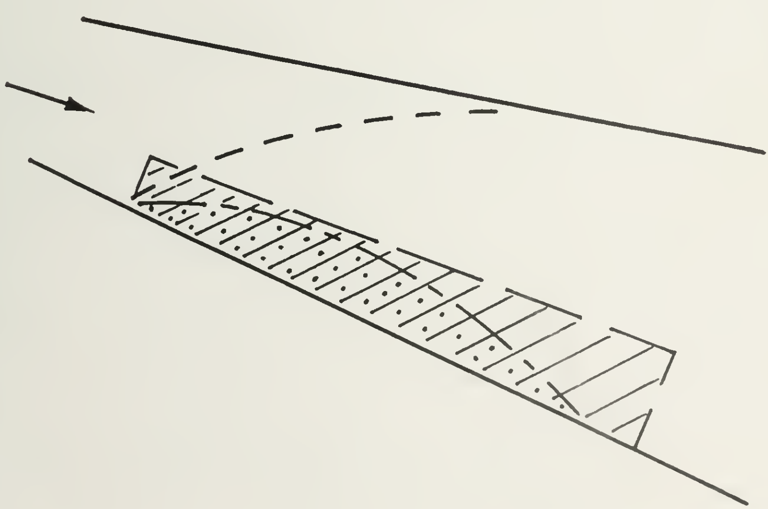
USER'S MANUAL

FOR

RIVER MIXING ZONE

ANALYSIS PROGRAMS



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FOR

RIVER MIXING ZONE

ANALYSIS PROGRAMS

Prepared for the
Ontario Ministry of the Environment
by
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NOTICE OF USER RESPONSIBILITY AND CONDITIONS ON THE USE OF MINISTRY OF THE ENVIRONMENT SOFTWARE

Additional copies of this manual and the accompanying software can be obtained by contacting:

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River Systems Section
Water Resources Branch

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USER'S MANUAL FOR MIXING ZONE ANALYSIS PROGRAMS

SUMMARY

This User's Manual describes the calibration and application of a personal computer package to predict the mixing zones in a shallow river for point and diffuser discharges. The package is set up in an interactive (enquiry/response) mode. The required site-specific data for the package are described. The package also predicts the critical points in any river transect where the provincial water quality objectives are achieved. The package outputs include many computer graphic options to assist the user. In the appendices, detailed technical discussions are presented on the various package components.

LOGICIELS D'ANALYSE DES ZONES DE MÉLANGE

MANUEL DE L'UTILISATEUR

SOMMAIRE

Le présent manuel de l'utilisateur montre comment étalonner et utiliser un progiciel servant à établir les zones de mélange dans une rivière peu profonde en cas de déversements ponctuels et de déversements diffus de polluants. Le progiciel fonctionne en mode dialogué (question-réponse). On énonce les données particulières relatives à l'emplacement étudié, dont on a besoin pour utiliser le progiciel. Le progiciel permet également de déterminer les critères précis selon lesquels une section de cours d'eau peut répondre aux objectifs de qualité de l'eau de la province. L'utilisateur pourra se servir de nombreux graphiques figurant parmi les états que peut créer le progiciel. Une description technique des éléments du progiciel figure en annexe.

MIXING ZONE ANALYSIS PROGRAMS

INTRODUCTION

Water pollution control plant effluents discharged into receiving streams and rivers often contain substances such as chlorine and ammonia which are potentially toxic to aquatic biota. Provincial Water Quality Objectives (PWQO) require the maintenance of a portion of the river as a favourable habitat for the biota termed the "zone of passage" (ZOP), wherein the concentrations of the pollutants comply with a specified water quality objective (Cs). The remaining portion of the river where the pollutant concentrations do not comply with the specified objective is called the limited use zone (LUZ). The salient features of the mixing zone are depicted in Figure 1. Effluents are usually discharged through outfalls at the river bank (i.e., point sources located at the shore), especially in shallow rivers, although diffuser outfalls are used in larger rivers.

This manual discusses the integrated use of a number of programs based on a steady-state mathematical model to predict the spatial concentration distributions in the mixing zones of shallow rivers. The model is based on the two-dimensional convective dispersion equation and utilizes the stream tube co-ordinate transform concept developed by Yotsukura & Cobb (1972). In this package, four programs, developed by T.P.H. Gowda are utilized. These programs have been combined with graphical output programs and interactive inputs for use by investigators of river water quality.

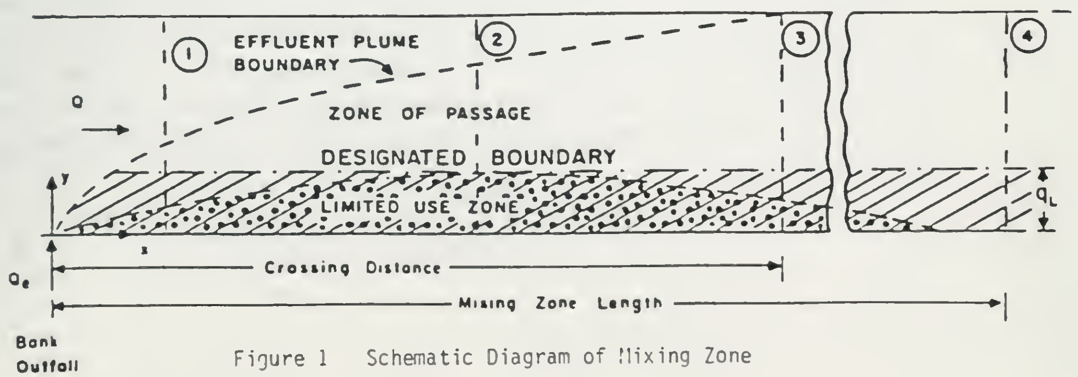


Figure 1 Schematic Diagram of Mixing Zone

FIELD STUDIES AND DATA COLLECTION

The collection of the required field data is important to the model predictions. In order to model the distributions of the effluent plume in a receiving river downstream from an outfall, measurements of salient features of the river must be made at several river cross-sections or transects at different distances from the outfall (Figure 2).

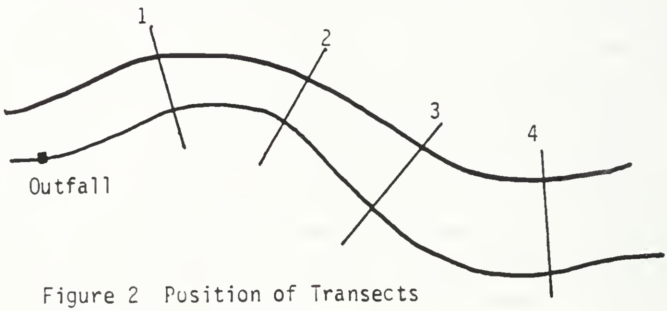


Figure 2 Position of Transects

For this package, measurements should be made at 4 to 8 transects downstream of the outfall. The position of the first transect should be far enough downstream from the source that concentration measurements reflect the behavior of the "far field" mixing regime or at least the further parts of the "intermediate field". The terms "near field", "intermediate field" and "far field" are used to differentiate mixing regimes in the mixing zone which are characterized by their time rates of growth of variance of contaminant clouds or plumes.

The "near field" mixing processes are dominated by jetting effects. The "intermediate field" is the region where the width of the plume is smaller than the largest turbulent motions present in a receiving water (river, lake etc). Here the growth rate of the variance of the plume (dispersion) is larger than that of the "far field" (See figure 3). The "far field" mixing processes are effected by all sizes of turbulent gyres present in the receiving water (ambient mixing processes).

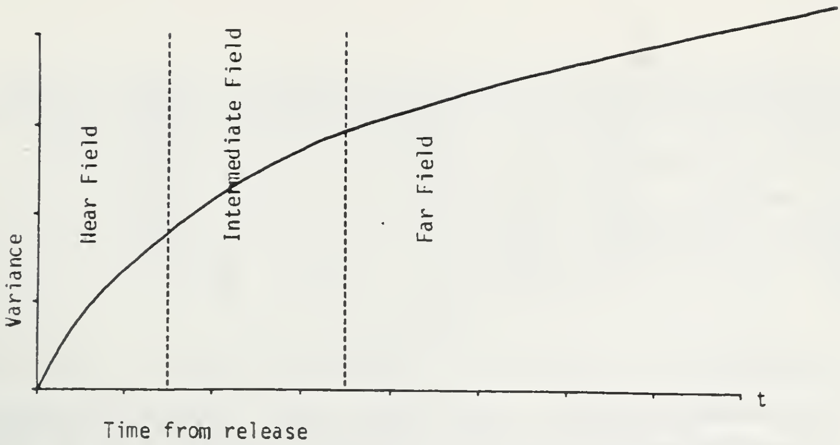


Figure 3 Variance versus Time

In the "far field" we can see that the dispersion $D = 1/2\ d\sigma^2/dt$ is a constant. In the "intermediate field" the dispersion D is larger than in the far field.

Data Required at Each Transect

The data used to drive this model should be in the following units.

- i) distances in meters
- ii) flow rates in cubic meters/second
- iii) velocities in meters/second
- iv) temperature in Celsius degrees

Concentration may be expressed in any unit desired since the equations are linear the output units will be the same as the input units.

The following measurements are necessary.

1. Distance downstream from outfall in meters.
2. Measurements at 10 to 25 points across the transect of:
   - i) distance y from the reference bank
   - ii) depth at y
   - iii) depth averaged velocity at y (optional)
   - iv) concentration of pollutant at y

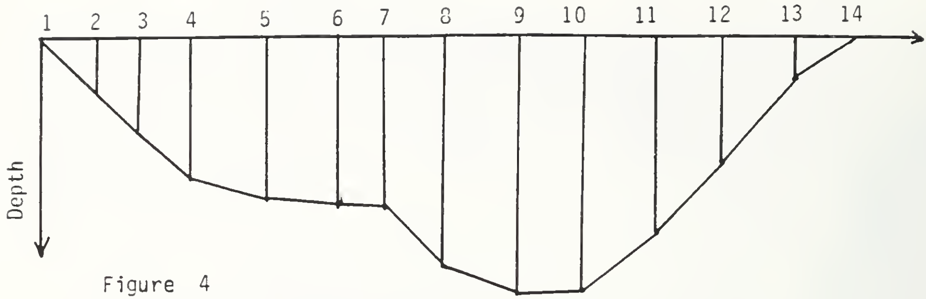


Figure 4

These measurements must be made at the same point at a distance y from the bank. The model assumes average depths, therefore parameters such as velocity or concentration must be taken at several depths at each point and averaged.

Further river data required are:

1. The contaminant being measured.
2. Flow rate of the river upstream of the outfall.
3. Flow rate of the effluent from the outfall.
4. Background concentration of the contaminant.
5. Effluent concentration of the contaminant.
6. The decay rate of the contaminant and the temperature at which this rate applies.
7. Temperature of the river.

Velocity measurements should be made at a minimum of two transects by following standard streamflow gauging procedures. Velocity measurements for two different flow rates is desirable. At transects where velocities are not measured, the Manning's equation can be used to simulate the velocity profiles using measured depth profiles.

Water samples must be collected at the upstream boundary, at the effluent outfall and at each point where cross-sectional depths and velocities are measured. However, the samples can be collected at selected points at each transect (viz., less points outside effluent plume, alternate points, etc.) to reduce sample analyses costs, in which case, the concentrations at other points are obtained by interpolation.

In order to account for fluctuations in effluent water quality and discharge on the instream concentrations, the sampling is carried out either by following the same plug of water beginning at the outfall and proceeding to successive downstream transects, or during a round-the-clock intensive survey when samples are collected at each point at 3-4 hour intervals. Obviously, the selection of a sampling methodology depends on the manpower, time and other resource constraints, as well as the objectives of the study.

The location of transects can be based on preliminary in-situ measurements of a conservative parameter (eg., conductivity) at selected access points to establish the approxiate longitudinal boundary of the mixing zone. In-situ measurements of temperature, pH and conductivity must be taken along with collection of samples which are to be analyzed in the laboratory for non-conservative pollutants of concern. In some cases, it may be desirable to inject a solution of dye continuously to gather data on the transverse distribution characteristics of the river. This is particularly useful to simulate effluent discharge from proposed outfall locations and in cases where relocation of an existing outfall is being considered. The dye injection must be maintained to establish steady-state conditions (about 2 or 3 hours). The cross-sectional distribution of dye at selected transects can be obtained directly by profiling with the fluorometer.

Generally, two surveys should be carried out under different instream hydraulic conditions so the model can be calibrated with one survey and verified with the second survey.

Data Analysis

The data collected during one of the field surveys is utilized to determine the parameters required for modelling. A Fortran computer program MIXANDAT is utilized to perform the following computations using the survey data as input:

1. Average depth and velocity at each transect.
2. Simulation of velocity distributions at cross-sections where velocities are not measured.
3. Shape-velocity factor at each transect.

4. Mass flux values of conservative and non-conservative materials at each transect.

5. Variance of cross-sectional distributions of conservative materials (used to evaluate the dispersion characteristics).

The Fortran program PREPARE is an interactive front-end for entering the survey data to be analyzed by MIXANDAT.

Mixing zone data analysis program MIXANDAT writes the analyzed data to a file called OUTAN.DAT which can be printed. An example of OUTAN.DAT is in Appendix D.

The plotting program PLTANDAT gives a graphical summary of the field data as well as the average depth and average velocity at each transect (Fig. 6 to 10).

In the output file OUTAN.DAT, the variances of cross-section distributions are listed for each transect.

MIXANDAT regresses the variances against different parameters to determine the dimensionless dispersion coefficient β. This method is described in detail in Reference 1. The program MIXANDAT chooses the regression of the least error and equates the slope of the linear regression with an expression from which β can be determined. This value of β is returned to the screen for use in the calibration procedure.

This dimensionless coefficient β is varied to calibrate the predicted contaminant spread with the observed concentration distributions. β may be considered to be at least weakly reach dependent, as it represents the rate of spread of a contaminant plume which in turn depends on the hydraulic and geometric properties of each river reach. The mathematical basis for β is discussed in more detail in Appendix A.

Model Calibration

The purpose of the calibration procedure is to calculate the dispersion parameter at each reach. Program MIXCALBN calculates a cross-stream concentration profile at each transect based on the spread β_i at transect i. Program COMPLOT is then used to produce a plot of predicted concentrations and

observed concentrations. From these plots the user can adjust the value of β at each transect to match the predicted with observed data. The user then runs MIXCALBN again with new estimates of β at each reach COMPLOT is run after each run of MIXCALBN. When the distributions of contaminant are close to coinciding the values of βi are recorded. These values are to be used in the prediction models.

Figures 11 to 13 show an example of the sequence required to obtain a good match.

Applications

Once the calibration is complete, the user may make predictions of the mixing zone for different design parameters. Parameters that may be varied include:

1. The lateral position of the outfall.
2. Type of outfall (pipe or diffuser).
3. Effluent and upstream river flow rates.
4. Effluent type (different decay rates).
5. Effluent concentration.
6. River background concentration.
7. River pH and temperature.

The program MIXPRED makes these predictions for a pipe outfall and program MIXCADIF does so for a diffuser outfall. The program CONMIX plots the resulting concentration distributions in the receiving water in three different formats (figures 14 to 16).

These programs determine the effects of changing certain parameters on river distributions, however as mentioned in the Introduction, the PWQO for an effluent discharge are based on the concept of the zone of passage. Program MIXAPPLN determines the "critical points" in the river for different flow rates, concentrations, contaminants and management options such as outfall location. "Critical point" are locations in the river transect where PWQO are achieved.

MIXAPPLN has an interactive query/response system as well as reading files generated by MIXANDAT and PLTANDAT. MIXAPPLN handles up to eight upstream flow rates, six effluent flow rates and six temperature values, as well as four pH values in the case of prediction of unionized ammonia levels. The output is summarized graphically by program PLTCRIT for each combination of design options (see Figure 17). The output file from MIXAPPLN (OUTAPP.DAT) is found in Appendix D.

The outputs for a particular case in MIXAPPLN are:

1. Critical values of concentrations and distances from the outfall at .1, .2, .3 and .4 of the total flow of the river. (That is, the border of the 1st, 2nd, 3rd and 4th stream tube).

2. Mixing Zone Length - that distance from the outfall to the point downstream where the pollutant is fully mixed across the cross-section and the corresponding average zone.

3. Maximum longitudinal spread.

A more detailed description of the critical point procedure can be found in Appendix A.

DETAILED USER'S MANUAL

Hardware and Software

The programs in this model package are written in FORTRAN-77 and satisfy all the requirements of Microsoft FTN-77 version 3.3. The mixing zone package is currently installed on a COMPAQ 286 microcomputer and hence will run on IBM PC and any 100% IBM PC compatibles with MS/DOS operating system. 256K of RAM is required to run the largest of the program's executable run files. The plotting programs use the PLOT88 graphics package which is licensed copyrighted software and the user will require this package in their library. The user will receive the mixing zone package in FORTRAN source code and must compile the code and load the library modules on their own system. The compile/load sequence using Microsoft FTN-77 is:

```
FOR1   program,,;
PAS2
LINK   /segments:256 program ,,, PLOT88 + Altmath + Fortran;
```

If a hard disk drive is present, all the source files can be copied from the floppy diskette to the hard disk and compiled there. If there is no hard drive, all the executable files will exceed the memory of a single diskette and therefore the source code programs should be copied 2 or 3 at a time to another floppy and compiled there. The following is a list of the programs in the order they are usually used:

PREPARE.FOR
MIXANDAT.FOR
PLTANDAT.FOR
MIXCALBN.FOR
COMPLOT.FOR
MIXPRED.FOR
MIXCADIF.FOR
CONMIX.FOR
MIXAPPLN.FOR
PLTCRIT.FOR

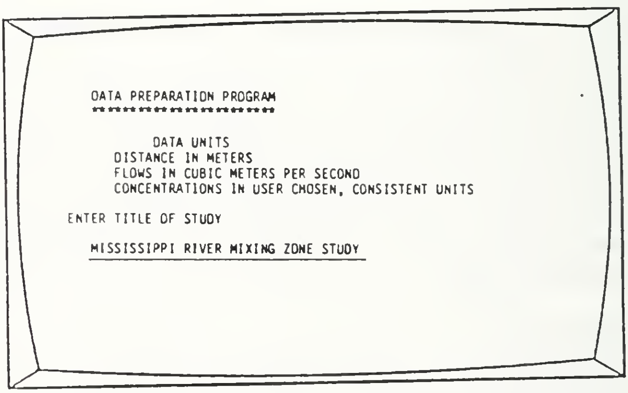
MIXING ZONE PACKAGE USER'S MANUAL

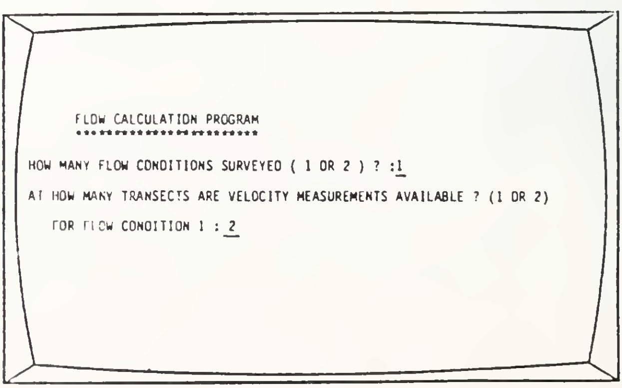
In this section the sequence of steps involved in using this mixing zone package consists of a text description with pictures of the corresponding display in the computer screen. The data that is used in the example of the screens is just for illustration purposes only and the underlined characters are those that are entered by the user.

1. Key PREPARE.

   This program will respond by prompting for field data, specifically velocity and depth data for at least one transect. It is most favourable to have measurements of two transects and at least flow conditions (i.e. low flow case and high flow case) so that the exponents in the Leopold - Maddock equations, as well as the total river flow may be determined. If data is available at only one flow condition, the Leopold - Maddock equations will use default values or user-entered values.

   The following diagrams are example of program PREPARE during a typical run.





```
ENTER THE FOLLOWING DATA FOR TRANSECT  1
****************************************

DEPTHS:  HOW MANY MEASUREMENT POINTS ACROSS THE RIVER ? 11

DEPTH  1          0
DEPTH  2          1.67
DEPTH  3          8.89
DEPTH  4          7.78
DEPTH  5          6.11
DEPTH  6          5.56
DEPTH  7          4.44
DEPTH  8          3.0
DEPTH  9          2.22
DEPTH 10          4.44
DEPTH 11          1.11
```

```
DISTANCE FROM SHORE OF EACH OF THE 11 POINTS

DISTANCE  1       0.
DISTANCE  2       16.67
DISTANCE  3       100.
DISTANCE  4       168.89
DISTANCE  5       188.89
DISTANCE  6       205.56
DISTANCE  7       228.89
DISTANCE  8       300.
DISTANCE  9       341.11
DISTANCE 10       441.11
DISTANCE 11       463.33
```

```
ENTER DEPTH AVERAGED VELOCITIES AT THE 11 POINTS

VELOCITY  1       0.
VELOCITY  2       .7
VELOCITY  3       .9
VELOCITY  4       1.2
VELOCITY  5       1.3
VELOCITY  6       1.3
VELOCITY  7       1.3
VELOCITY  8       1.6
VELOCITY  9       1.2
VELOCITY 10       .8
VELOCITY 11       0.
```

```
ENTER FIELD DATA COLLECTED AT RIVER TRANSECTS

ENTER NUMBER OF TRANSECTS: 5
NAME OF POLLUTANT: AMMONIA
FLOW RATE OF EFFLUENT: 76
CONCENTRATION OF EFFLUENT: 15.
BACKGROUND CONCENTRATION: 0.
BANK OF OUTFALL (RIGHT OR LEFT): RIGHT
TEMPERATURE OF RIVER: 22.9
DECAY RATE OF CONTAMINANT IN RIVER: .0000231
TEMPERATURE AT WHICH THIS RATE IS KNOWN: 20.
```

```
TRANSECT # 1

DISTANCE DOWNSTREAM FROM OUTFALL: 200
HOW MANY MEASUREMENTS ACROSS THIS TRANSECT: 11
```

```
ENTER DISTANCE MEASURED FROM RIGHT BANK

 1:          0.
 2:          16.67
 3:          44.44
 4:          83.33
 5:          132.22
 6:          150.
 7:          177.78
 8:          222.22
 9:          333.33
10:          444.44
11:          551.11
```

```
ENTER DEPTH FROM RIGHT BANK

1:            0.
2:            1.67
3:            8.89
4:            7.78
5:            6.11
6:            5.56
7:            4.44
8:            3.
9:            2.22
10:           4.44
11:           1.11
```

```
ENTER CONCENTRATIONS FROM RIGHT BANK

1:            8.
2:            6.
3:            1.
4:            .5
5:            0.
6:            0.
7:            0.
8:            0.
9:            0.
10:           0.
11:           0.
```

2. Key MIXANDAT.

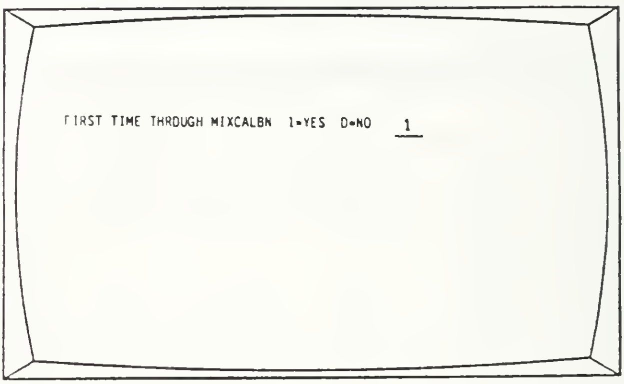
   Program MIXANDAT performs an analysis of the field data. This program returns a value of BETA to be used in subsequent programs.

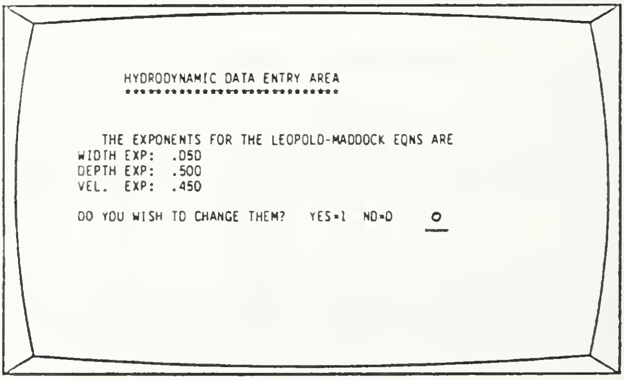
3. Key PLTANDAT.

   Program PLTANDAT gives a graphical summary of the field data. (See Figures 6 to 10 for example). PLTANDAT is responsible for writing a file to be used by Program COMPLOT and hence this step cannot be missed. In the case of plotting to the screen, strike any key after each plot to continue to the next.

4. Key MIXCALBN.

This is the mixing zone calibration program and is used to adjust the model parameters to match predicted with observed concentration data. MIXCALBN is typically run 3 to 4 times to arrive at a calibrated situation. In order to compare the observed data with the predicted data each time, run the program COMPLOT after each run of MIXCALBN. The following screen diagrams illustrate a typical first run through MIXCALBN.





```
DECAY RATE DATA ENTRY AREA
**************************

ENTER A DECAY RATE FOR THE RIVER BACKGROUND:  .0000231

ENTER A DECAY RATE AT EACH TRANSECT

TRANSECT  1 : .0000231
TRANSECT  2 : .0000231
TRANSECT  3 : .0000231
TRANSECT  4 : .0000231
TRANSECT  5 : .0000231

AT WHAT TEMPERATURE IS THIS RATE KNOWN? IN C : 20

WHAT IS THE RIVER TEMPERATURE: IN C : 22.9
```

```
DO YOU WISH TO CONSIDER AMMONIA?  YES=1  NO=0   1
ENTER PH 8.3
```

```
ENTER VALUES OF BETA

TRANSECT          1 : .00092
TRANSECT          2 : .00092
TRANSECT          3 : .00092
TRANSECT          4 : .00092
TRANSECT          5 : .00092

THE OUTPUT FILE FROM MIXCALBN. FOR IS CALLED

           " CALOUT.DAT "

STOP - PROGRAM TERMINATED.
```

5. Key COMPLOT.

Figures 11 to 13 show an example of the graphics output by COMPLOT. At each transect, observed concentrations and predicted concentrations are graphed on the same set of axes. Values for mean concentration and spread for both the observed and predicted concentrations are printed as well as the value of BETA that was used in the prediction. It is suggested that calibration be done with a conservative contaminant. For a non-conservative contaminant, its decay rate must be obtained from literature. The value BETA is proportional to the spread of the predicted distributions and hence by increasing BETA at a transect in the next run of MIXCALBN, will increase the spread of the next predicted concentration distribution. The mean concentrations that are printed correspond to the concentration that would be observed if the same amount of pollutant were fully mixed across the river transect. It should be equal to:

$$C_A = \frac{QEFL*CEFL}{QRS}$$

where C_A = average concentration

QEFL = flow rate of effluent

CEFL = concentration of effluent

QRS = total flow of river below outfall

The predicted curves will have a mean concentration C_A at all transects (unless the spread is quite small and then it may overestimate C_A). Hence deviations from this mean by the observed data reflect the quality of the data and it is not necessarily desirable to match these mean concentrations.

A second estimate of BETA is made for each transect and the user returns to Step 4 (i.e., keys MIXCALBN and enters the new BETA values). For a true far field mixing zone, BETA should be only moderately reach dependent and lie in a range of .0025 to .0001 approximately. If, however, any of the transects are located closer to the outfall, the mixing zone area may fall into an intermediate field regime where the BETA values are dependent on distance from the source. For transects near the outfall, the BETA value used may have to be larger to obtain the correct spread. MIXCALBN is run until the curves and spread values are as close as possible then the calibration is finished. These BETA values must be noted for use in subsequent programs.

Now that the model is calibrated, the mixing zone package may be used for design applications. The 3 design application programs are MIXAPPLN, MIXPRED and MIXCADIF. Any of these three programs may be run now.

6. Key MIXAPPLN.

MIXAPPLN acts interactively to input different combinations of river flow, effluent flow, river temperature on different possible pollutants. An explanation of the critical point method is given in Appendix A. The following screen diagrams illustrate how to run MIXAPPLN.

```
SUMMARY OF INPUT DATA
*********************

REFERENCE RIVER PARAMETERS


TOTAL RIVER FLOW BELOW OUTFALL AT TIME OF SURVEY :   2374.020

TRANSECT DISTANCE  RIVER WIDTH  AVERAGE DEPTH  AVERAGE VELOCITY
      200.00         551.11         3.97            1.08
     2000.00         463.33         4.33            1.18
     4500.00         677.78         2.19            1.60
    10150.00         355.56         5.85            1.14
    17450.00         750.00         3.40             .93

NOW YOU MAY ENTER DESIGN PARAMETERS
STRIKE [ENTER] TO CONTINUE
```

```
ENTER STUDY TITLE : MISSISSIPPI RIVER MIXING ZONE STUDY

ENTER POLLUTANT NAME : AMMONIA
```

```
ENTER # OF UPSTREAM FLOW RATES ( 9) : 5

ENTER THESE FLOW RATES

RATE  1: 3000

RATE  2: 2700

RATE  3: 2500

RATE  4: 2000

RATE  5: 1500
```

```
ENTER # OF EFFLUENT FLOW RATES ( 7) : 3
ENTER THESE FLOW RATES
RATE  1: 100
RATE  2: 50
RATE  3: 10
```

```
ENTER # OF RIVER TEMPERATURES ( 7) : 4
ENTER THESE TEMPERATURES
   TEMP.          1: 25.
   TEMP.          2: 22.
   TEMP.          3: 18
   TEMP.          4: 10
```

```
ARE YOU CONSIDERING AMMONIA? 1=YES  0-NO : 1
ENTER # OF PH VALUES ( 5) : 2
ENTER THESE PH VALUES
   PH 1:  7.
   PH 2:  8.3
ENTER EFFLUENT CONCENTRATION : 15
ENTER BACKGROUND CONCENTRATION : 0.
ENTER PROVINCIAL WATER QUALITY OBJECTIVE : .02
ENTER TEMPERATURE COEFFICIENT : 1.106
ENTER DECAY RATE OF BACKGROUND : .0000231
ENTER THE TEMPERATURE THIS RATE IS KNOWN AT : 20
```

```
ENTER VALUES OF BETA

      TRANSECT   1: .004
      TRANSECT   2: .0017
      TRANSECT   3: .00078
      TRANSECT   4: .001
      TRANSECT   5: .0007

ENTER DECAY RATES AT EACH TRANSECT

      TRANSECT   1: .0000231
      TRANSECT   2: .0000231
      TRANSECT   3: .0000231
      TRANSECT   4: .0000231
      TRANSECT   5: .0000231
```

7. Key PLTCRIT.

   PLTCRIT outputs a graphical summary of the output from MIXAPPLN for each of the design option combinations (see Figure 17).

8. Key MIXPRED.

   MIXPRED computes the two dimensional concentration distribution for a pipe outfall located some distance from shore for user defined design parameters. The following screen diagrams illustrate how to use MIXPRED.

```
   THE EXPONENTS FOR THE LEOPOLD-MADDOCK EQNS ARE

WIDTH EXP:        .050
DEPTH EXP:        .500
VEL.  EXP:        .450

DO YOU WISH TO CHANGE THEM?  YES=1  NO=0  : 0
```

```
   RIVER FLOW RATE ABOVE OUTFALL = 2298.02
   OUTFALL FLOW RATE = 76.00

DO YOU WISH TO CHANGE EITHER?  YES=1  NO=0    1
RIVER FLOR RATE = 3000
OUTFALL FLOW RATE = 100
```

```
THE EFFLUENT CONCENTRATION IS : 15.00

   DO YOU WISH TO CHANGE IT?  YES=1 NO=0    1

THE NEW EFFLUENT CONC. = 20
```

```
        THE BACKGROUND CONCENTRATION IS : .00

   DO YOU WISH TO CHANGE IT?  YES=1  NO =0    1

ENTER NEW BACKGROUND CONC.:  2.
```

```
ENTER A DECAY RATE FOR THE RIVER BACKGROUND:  .0000231
AT WHAT TEMPERATURE IS THIS RATE KNOWN?  IN C : 20.
WHAT IS THE RIVER TEMPERATURE? IN C : 22.9
```

```
    THE OUTFALL IS AT SHORE
  DO YOU WISH TO CHANGE IT?  YES=1  NO=0        1
ENTER THE DISTANCE OF THE OUTFALL FROM THE BANK : 100.
```

```
  DO YOU WISH TO CONSIDER AMMONIA?  YES=1  NO=0    1
ENTER PH 8.3
```

```
        ENTER  5 VALUES OF OECAY

     TRANSECT       1 : .0000231
     TRANSECT       2 : .0000231
     TRANSECT       3 : .0000231
     TRANSECT       4 : .0000231
     TRANSECT       5 : .0000231

     ENTER VALUES OF BETA

     TRANSECT       1 : .004
     TRANSECT       2 : .0017
     TRANSECT       3 : .00078
     TRANSECT       4 : .001
     TRANSECT       5 : .0007

     THE OUTPUT FILE FROM MIXPRED. FOR IS CALLED
             " PREDOUT.OAT "
  STOP - PROGRAM TERMINATED.
```

9. Key CONMIX.

   CONMIX gives the choice of 3 different graphical representations, of which the user may choose 1, 2 or all of them (Figure 14 to 16).

10. Key MIXCADIF

    Program MIXCADIF is almost identical to program MIXPRED except that MIXCADIF applies to predictions of distributions when diffuser outfalls are used.

11. Key CONMIX

    CONMIX also gives graphical summary of results from MIXCADIF.

```
    PLOT THE FOLLOWING TYPE OF PLOT  1=YES  0=NO

       CROSS STREAM CONCENTRATION PROFILES:  1

       2 DIMENSIONAL CONTOUR PLOT:  1

       3 DIMENSIONAL MESH PLOT:  1

    ENTER POLLUTANT NAME (30 LETTERS MAX) : AMMONIA

 PLOT LOCATION 1-SCREEN 2-PLOTTER 3=PRINTER : 1
```

REFERENCES

1. Gowda, T.P.H., 1980. Stream Tube Model for Water Quality Prediction in Mixing Zones of Shallow Rivers. Water Resources Paper No. 14, Water Resources Branch, Ontario Ministry of the Environment. 142 pp.

2. Gowda, T.P.H., 1984. Water Quality Prediction in Mixing Zones in Rivers. Amer. Soc. Civil Eng., J. Environ. Eng. 110; 751-769.

3. Gowda, T.P.H., 1984. Critical Point Method for Mixing Zones in Rivers. Amer. Soc. Civil Eng., J. Environ. Eng. 110; 244-262.

4. Leopold, L.B. and Maddock, T. Jr., 1953. The Hydraulic Geometry of Stream Channels and Some Physiographic Implications. Geological Survey Professional Paper 252. United States Government Printing Office.

5. Post, L.E. and Gowda, T.P.H., 1984. Mixing Zone Studies in the Grand River Basin. Cdn. J. Civil Eng., 11; 204-216.

6. Sayre, W.W., 1975. Dispersion of Mass in Open Channel Flow. Hydrology Papers. Colorado State University. No. 75.

7. Stream Water Quality Assessment, Procedures Manual, March 1980. Ontario Ministry of the Environment, Water Resources Branch, Water Modelling Section.

8. Yotsukura, N. and Cobb, E.D., 1972. Transverse Diffusion of Solutes in Natural Streams. U.S. Geological survey Professional Paper 582-C, U.S. Gov't. Printing Office, Washington, D.C. 19 pp.

FIGURES

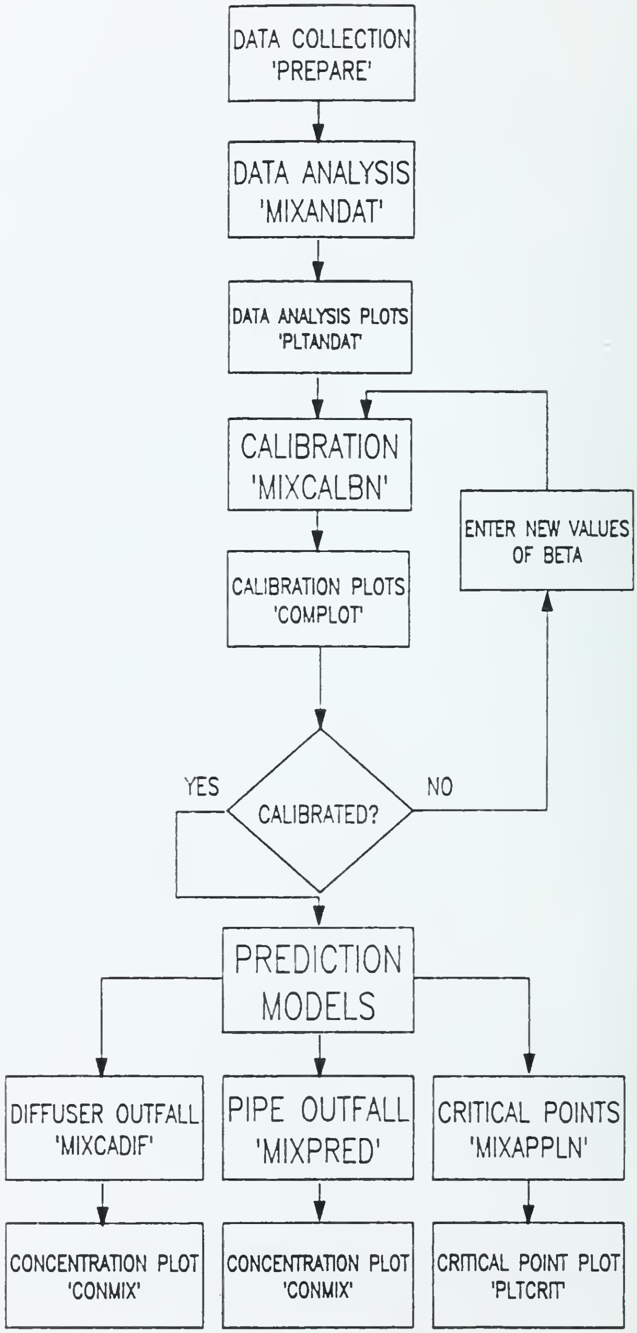


Figure 5   Flow Diagram of Mixing Zone Package

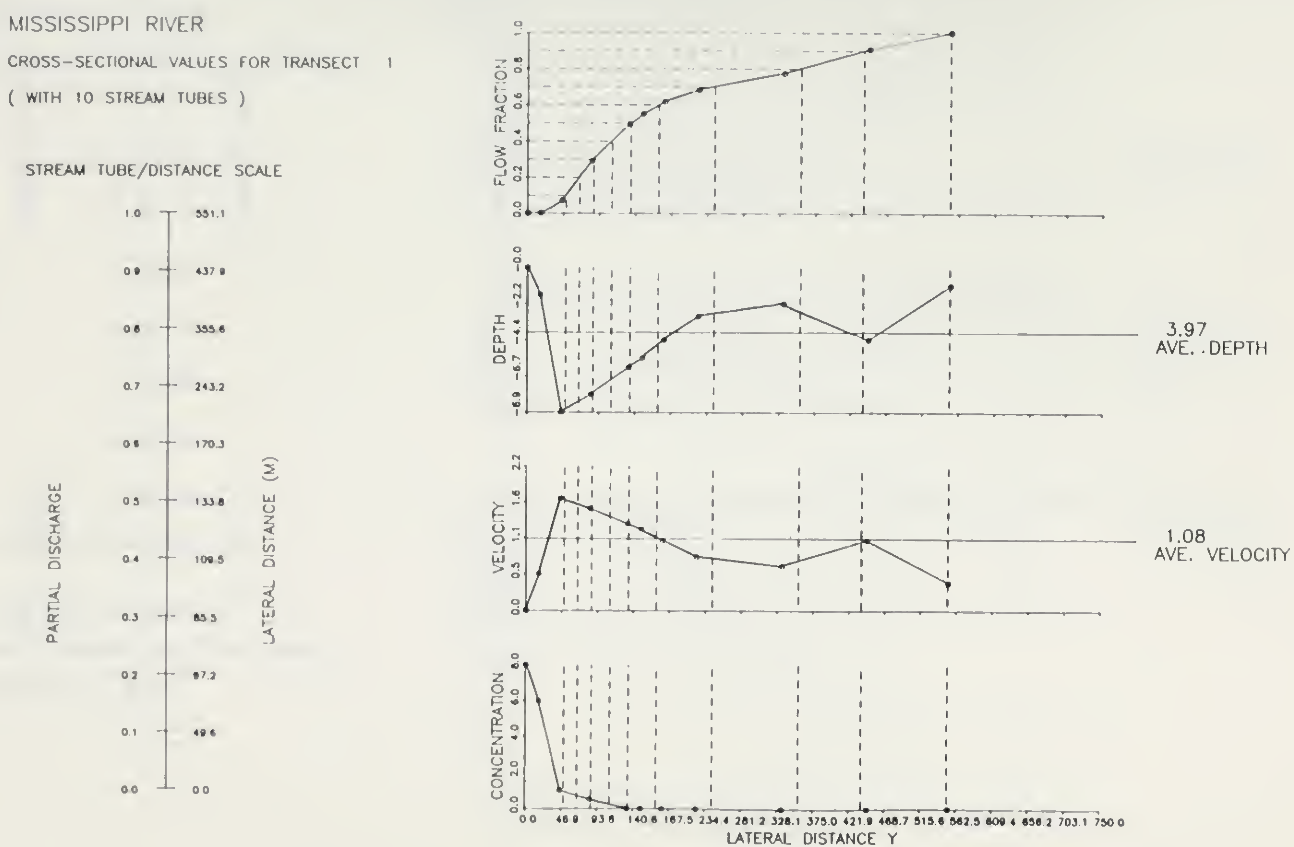
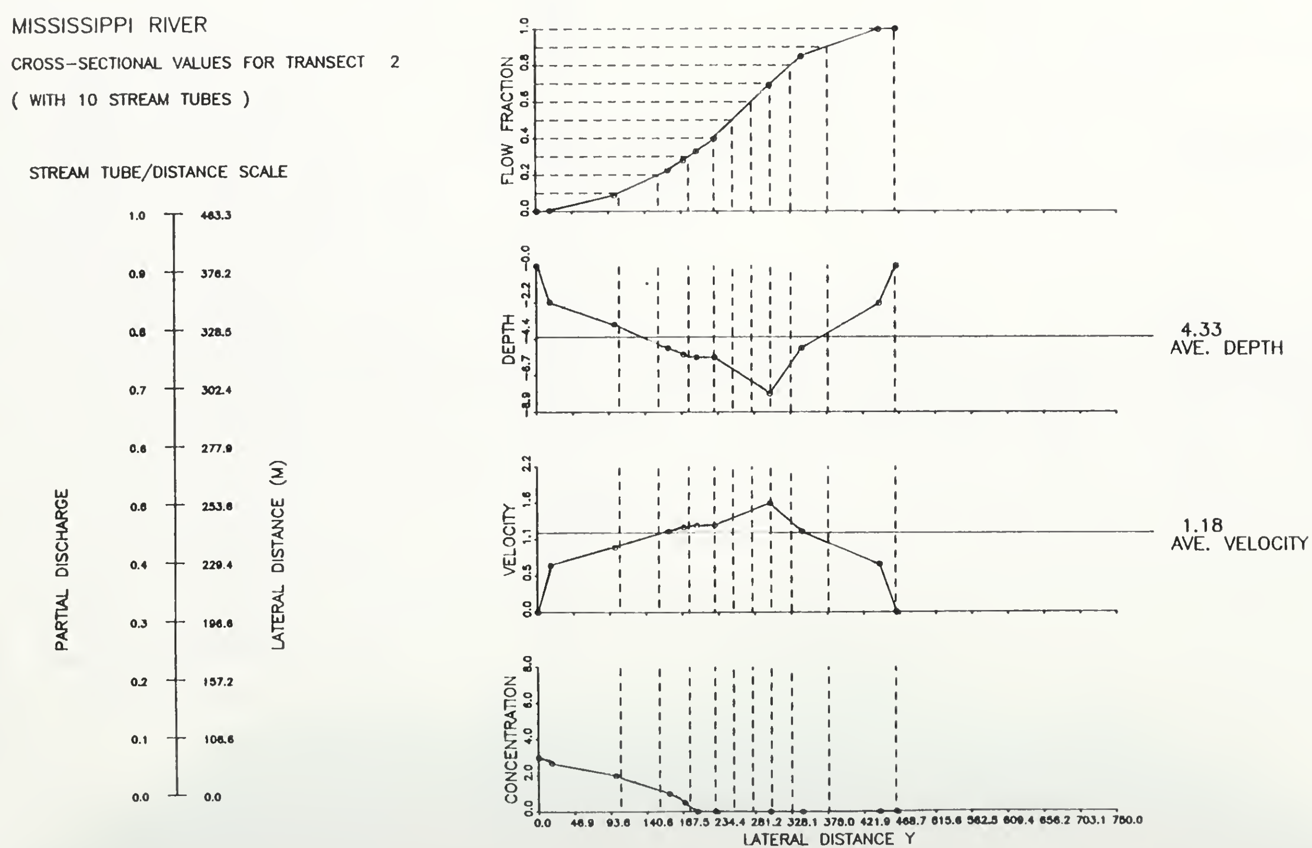

MISSISSIPPI RIVER
CROSS-SECTIONAL VALUES FOR TRANSECT 1
(WITH 10 STREAM TUBES)
STREAM TUBE/DISTANCE SCALE
PARTIAL DISCHARGE
LATERAL DISTANCE (M)
1.0 551.1
0.9 437.9
0.8 355.6
0.7 243.2
0.6 170.3
0.5 133.8
0.4 109.5
0.3 85.5
0.2 67.2
0.1 49.6
0.0 0.0
FLOW FRACTION
DEPTH
3.97
AVE. .DEPTH
VELOCITY
1.08
AVE. VELOCITY
CONCENTRATION
LATERAL DISTANCE Y

Figure 6



MISSISSIPPI RIVER
CROSS-SECTIONAL VALUES FOR TRANSECT 2
(WITH 10 STREAM TUBES)
STREAM TUBE/DISTANCE SCALE
PARTIAL DISCHARGE
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
LATERAL DISTANCE (M)
463.3
376.2
328.5
302.4
277.9
253.8
229.4
196.6
157.2
106.6
0.0
FLOW FRACTION
DEPTH
4.33
AVE. DEPTH
VELOCITY
1.18
AVE. VELOCITY
CONCENTRATION
0.0 46.9 93.6 140.6 167.5 234.4 281.2 328.1 375.0 421.9 468.7 515.6 562.5 609.4 656.2 703.1 750.0
LATERAL DISTANCE Y

Figure 7

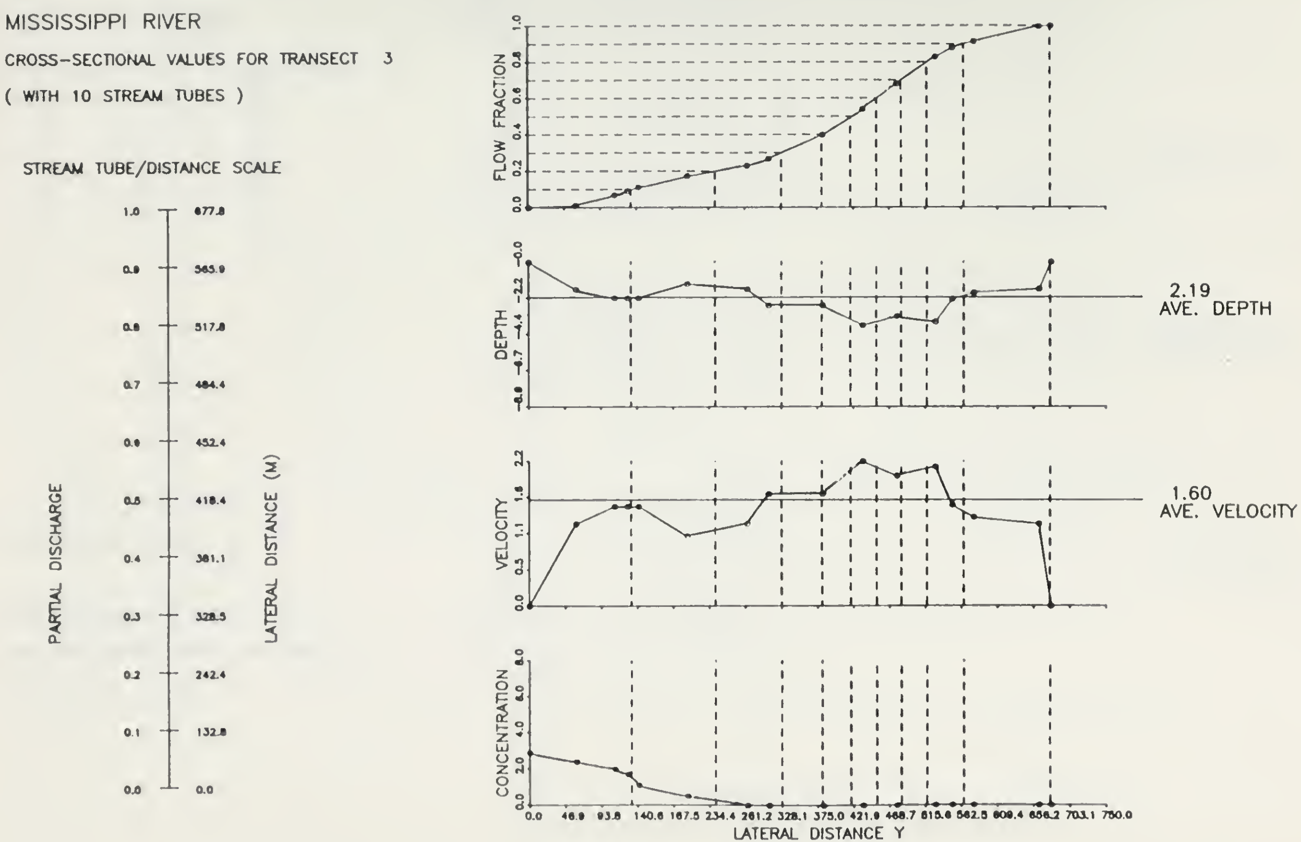

MISSISSIPPI RIVER
CROSS-SECTIONAL VALUES FOR TRANSECT 3
(WITH 10 STREAM TUBES)
STREAM TUBE/DISTANCE SCALE
PARTIAL DISCHARGE
LATERAL DISTANCE (M)
1.0 677.8
0.9 565.9
0.8 517.8
0.7 484.4
0.6 452.4
0.5 418.4
0.4 381.1
0.3 328.5
0.2 242.4
0.1 132.8
0.0 0.0
FLOW FRACTION
DEPTH
2.19
AVE. DEPTH
VELOCITY
1.60
AVE. VELOCITY
CONCENTRATION
LATERAL DISTANCE Y

Figure 8

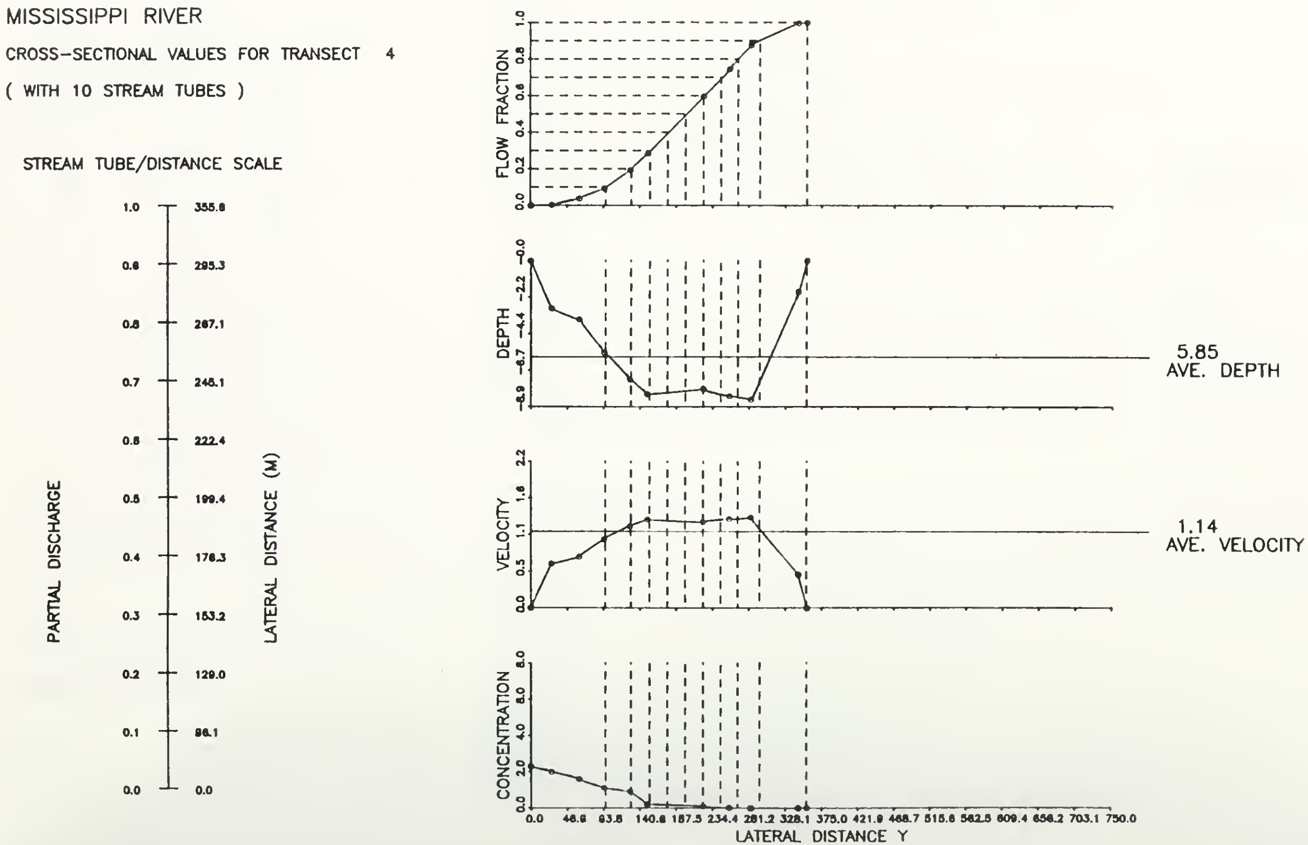

MISSISSIPPI RIVER
CROSS-SECTIONAL VALUES FOR TRANSECT 4
(WITH 10 STREAM TUBES)
STREAM TUBE/DISTANCE SCALE
PARTIAL DISCHARGE
LATERAL DISTANCE (M)
1.0 355.8
0.8 295.3
0.8 267.1
0.7 246.1
0.8 222.4
0.5 199.4
0.4 176.3
0.3 153.2
0.2 129.0
0.1 86.1
0.0 0.0
FLOW FRACTION
DEPTH
5.85
AVE. DEPTH
VELOCITY
1.14
AVE. VELOCITY
CONCENTRATION
0.0 46.8 93.8 140.6 187.5 234.4 281.2 328.1 375.0 421.9 468.7 515.6 562.5 609.4 656.2 703.1 750.0
LATERAL DISTANCE Y

Figure 9

MISSISSIPPI RIVER

CROSS-SECTIONAL VALUES FOR TRANSECT 5

(WITH 10 STREAM TUBES)

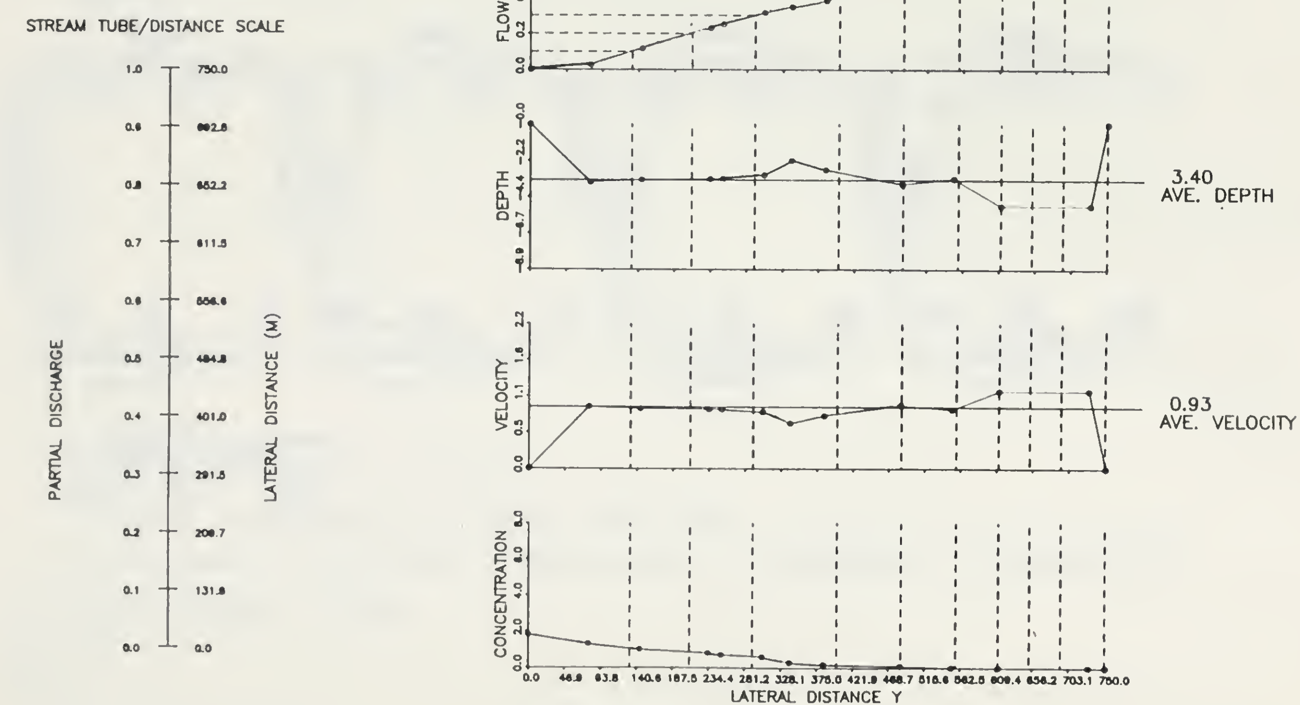


Figure 10

MISSISSIPPI RIVER

COMPARISON OF OBSERVED CONCENTRATIONS TO CALIBRATION CONCENTRATIONS

LATERAL COORDINATES IN STREAM TUBE UNITS

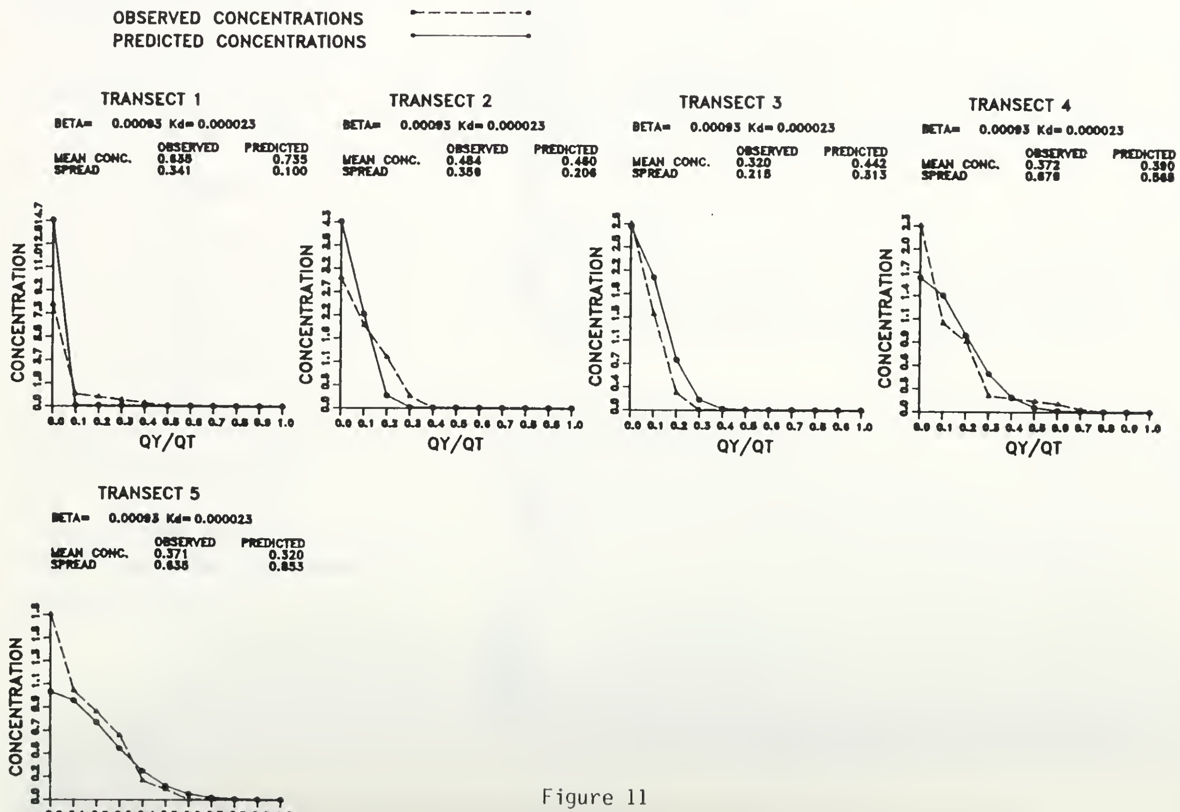


Figure 11

MISSISSIPPI RIVER

COMPARISON OF OBSERVED CONCENTRATIONS TO CALIBRATION CONCENTRATIONS

LATERAL COORDINATES IN STREAM TUBE UNITS

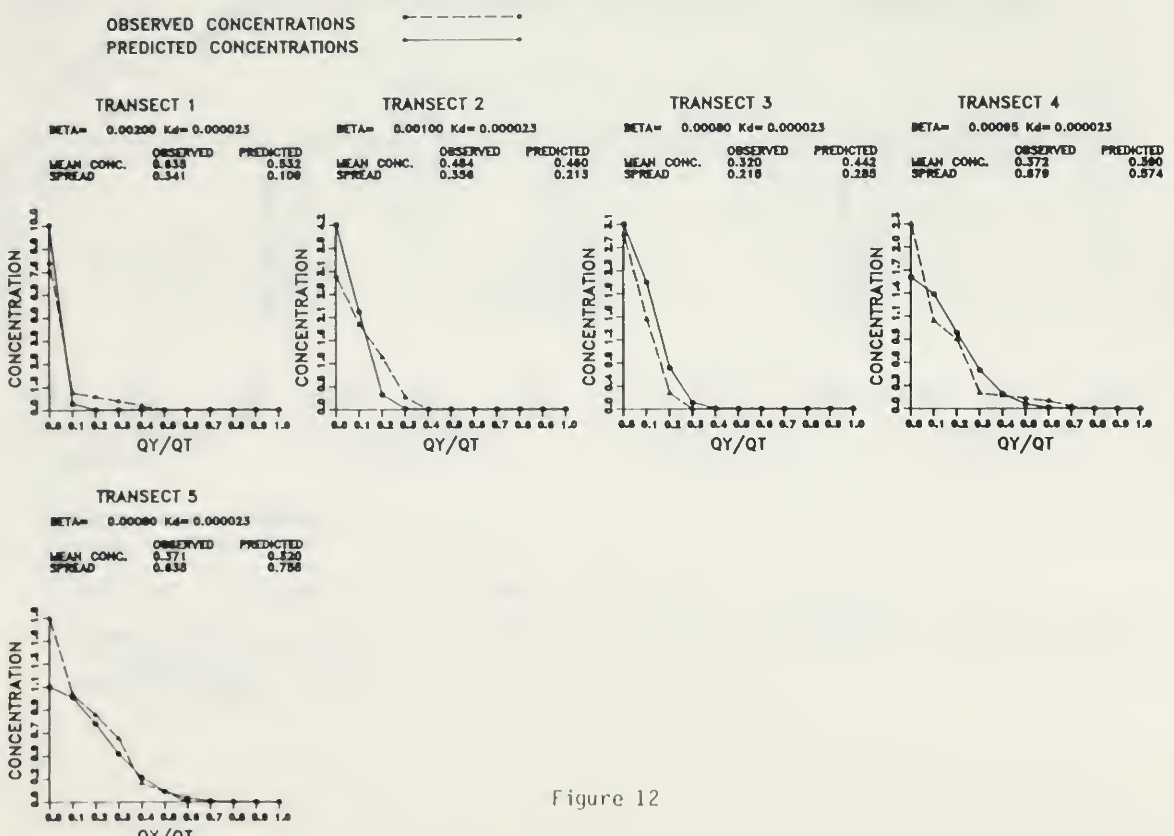


Figure 12

MISSISSIPPI RIVER

COMPARISON OF OBSERVED CONCENTRATIONS TO CALIBRATION CONCENTRATIONS

LATERAL COORDINATES IN STREAM TUBE UNITS

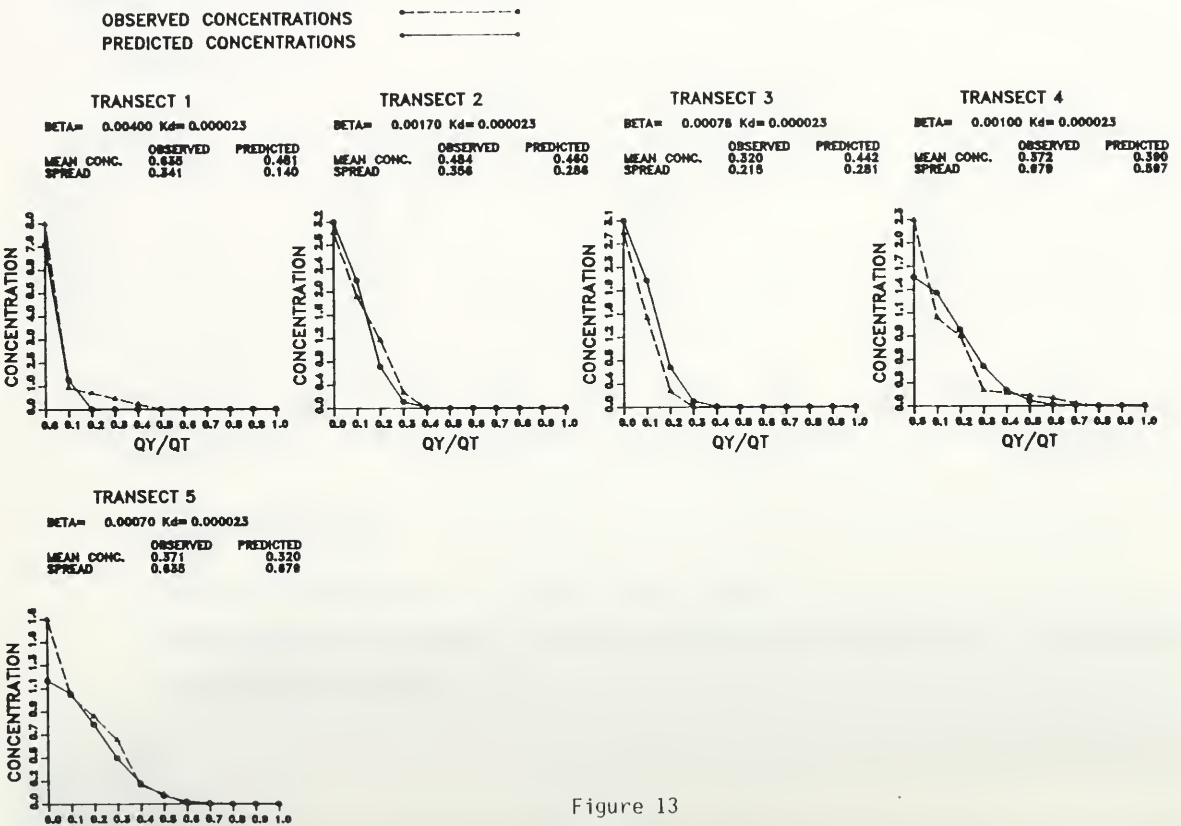


Figure 13

MISSISSIPPI RIVER

POLLUTANT:	AMMONIA	
RIVER FLOW RATE ABOVE OUTFALL :	3000.00	CMS
EFFLUENT FLOW RATE :	75.00	CMS
EFFLUENT CONCENTRATION :	20.00	
BACKGROUND CONCENTRATION :	0.00	
PIPE OUTFALL LOCATION :	100.00	METERS FROM BANK

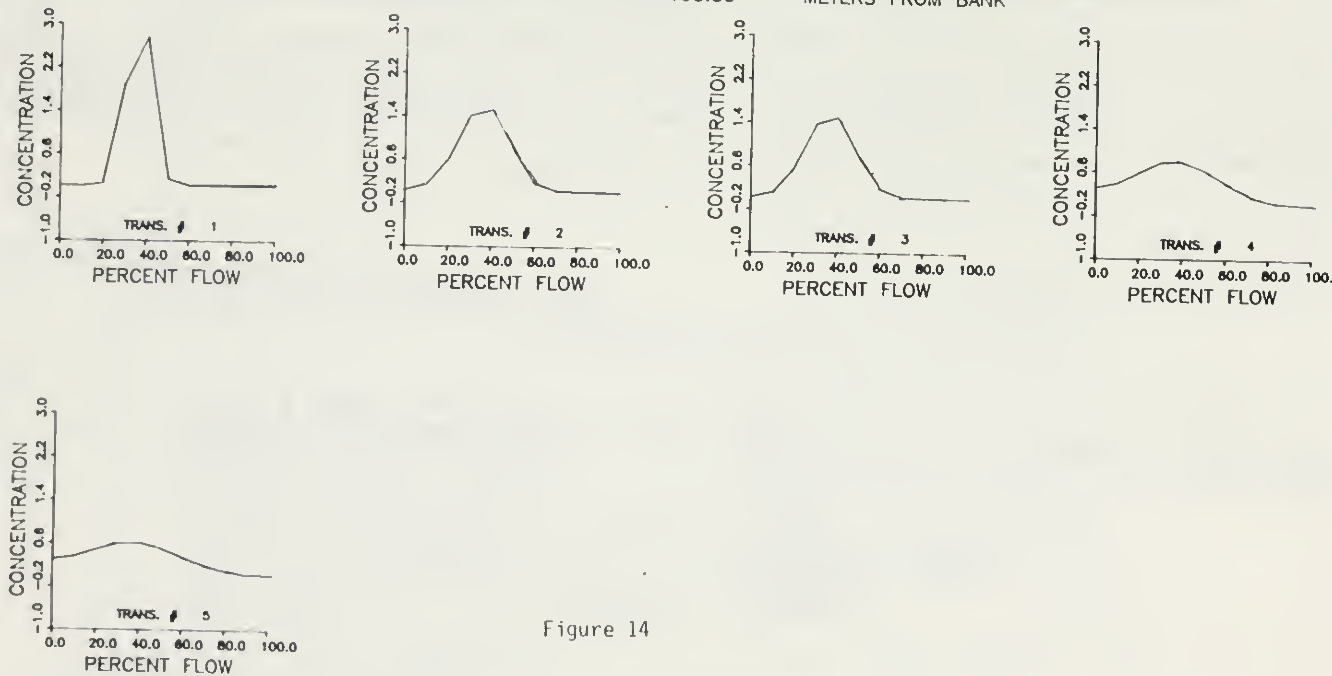
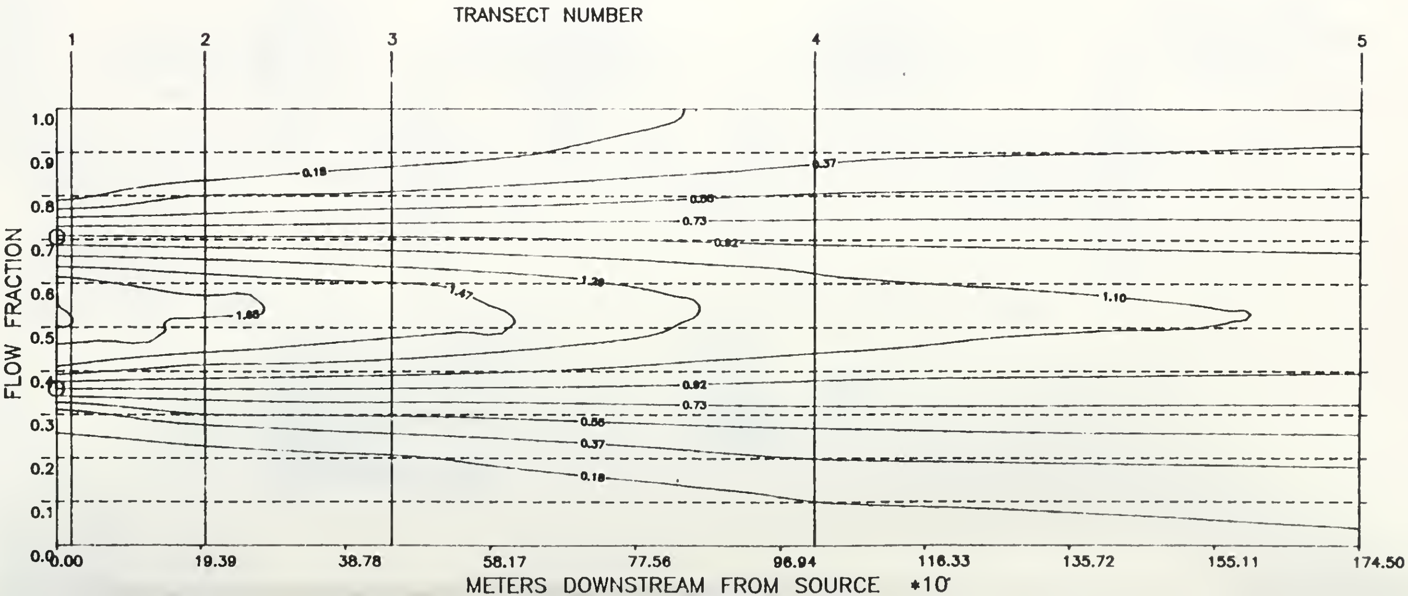


Figure 14

MISSISSIPPI RIVER

POLLUTANT:	AMMONIA		
RIVER FLOW RATE ABOVE OUTFALL :	3000.00	CMS	
EFFLUENT FLOW RATE :	100.00	CMS	
EFFLUENT CONCENTRATION :	20.00		
BACKGROUND CONCENTRATION :	0.00		
DIFFUSER OUTFALL LOCATION :	100.00	TO	250.00 METERS FROM BANK
NUMBER OF DIFFUSER PORTS :	10.		
DIFFUSER ENDS MARKED AS :	⦶		



MISSISSIPPI RIVER

POLLUTANT:	AMMONIA		
RIVER FLOW RATE ABOVE OUTFALL :	3000.00	CMS	
EFFLUENT FLOW RATE :	100.00	CMS	
EFFLUENT CONCENTRATION :	20.00		
BACKGROUND CONCENTRATION :	0.00		
DIFFUSER OUTFALL LOCATION :	100.00	TO	250.00 METERS FROM BANK
NUMBER OF DIFFUSER PORTS :	10.		

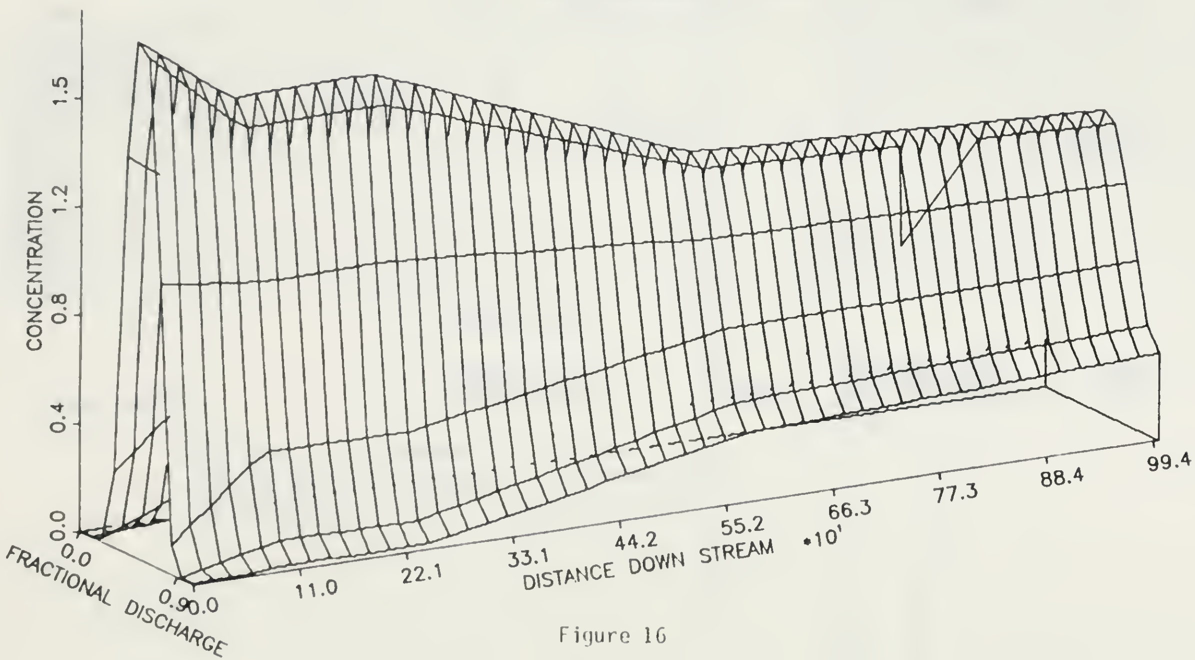


Figure 16

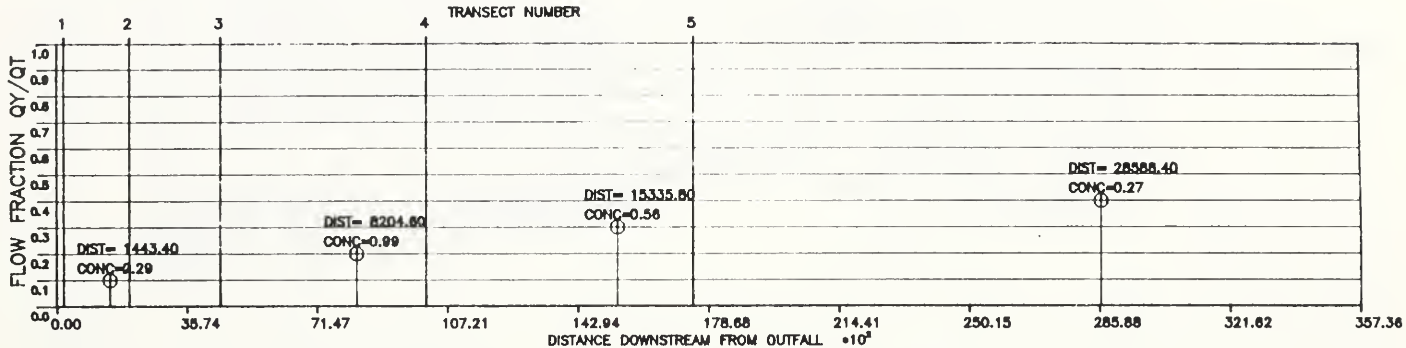
MISSISSIPPI RIVER – TEST DATA

PLOT OF CRITICAL POINTS FROM PROGRAM MIXAPPLN

POLLUTANT : AMMONIA

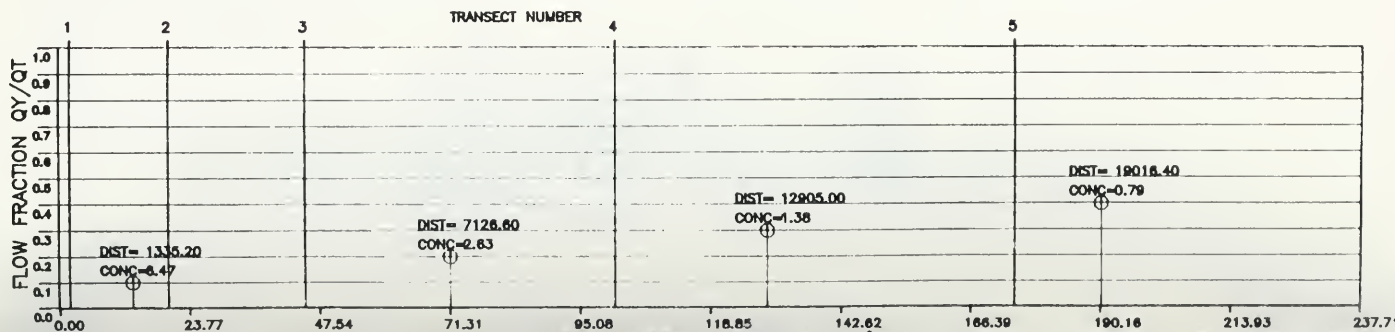
RUN NUMBER 1.

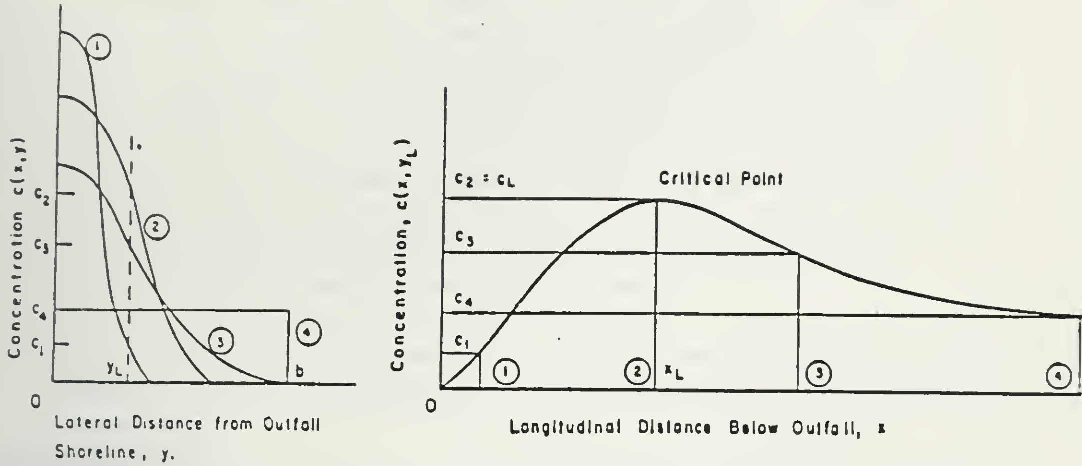
RIVER FLOW RATE =	3000.000	EFFLUENT CONCENTRATION =	20.00
EFFLUENT FLOW RATE =	75.000	RIVER TEMPERATURE =	22.0
RIVER ACIDITY; PH =	8.3	MIXING ZONE LENGTH =	1085378.6



RUN NUMBER 2.

RIVER FLOW RATE =	1000.000	EFFLUENT CONCENTRATION =	20.00
EFFLUENT FLOW RATE =	75.000	RIVER TEMPERATURE =	22.0
RIVER ACIDITY; PH =	8.3	MIXING ZONE LENGTH =	1029815.4





(a) CONCENTRATION PROFILES AT CROSS-SECTIONS ① TO ④

(b) LONGITUDINAL PROFILE ALONG A LATERAL BOUNDARY OF LIMITED USE ZONE.

Figure 18 Critical Point of LUZ

APPENDIX A

STREAM TUBE MODEL

APPENDIX A
BASIC STREAM TUBE MODEL[1]

The fundamental concept of the stream tube model, developed by Yotsukura and Cobb, (1972) is the use of the cumulative partial discharge, q, at a given cross-section instead of the lateral distance, y, as the independent variable. In this approach, the river cross section is divided into a number of vertical strips termed "stream tubes", such that the discharge within each stream tube is the same. Thus, the cross sectional concentration distributions, c(x,q), predicted by the stream tube model will be functions of q. These distributions can be transformed into c(x,y) as a function of distance from the bank, y, by knowing the relation between q and y at each transect.

The derivations of the basic equations of the stream tube model have been presented by Yotsukura and Cobb (ibid); they are subject to the following assumptions:

1. The density of effluent (or solute) is the same as that of the receiving water. This assumption is reasonably satisfactory for most of the municipal effluent discharges to rivers.

2. The concentration distributions in the far field are not affected by the near field mixing processes (eg., dilution due to initial momentum of jet). Usually, the jet-induced diffusion approaches the ambient diffusion for a short distance below a source in a shallow river.

3. The depth distribution of effluent (or solute) in the river channel is uniform. Generally, the longitudinal distance required to attain depth uniformity is short in shallow rivers, being of the order of 50 to 100 times the channel depth; thus, the assumption is justified.

4. The transport due to longitudinal dispersion is negligible. In the case of continuous effluent discharge, this transport is very small in relation to that due to convection and lateral dispersion, thus justifying the assumption.

The Convective-Dispersion Equation

The two-dimensional convective-dispersion equation for a non-conservative material in the far field region of the mixing zone can be written in the following form:

---

[1] From Reference 1.

$$\frac{\partial c}{\partial x} = Dy\,\frac{\partial^2 c}{\partial q^2} - \frac{m_x Kdc}{u} \qquad (2)$$

where x = distance downstream from outfall
q = partial cumulative discharge
Dy = lateral diffusion factor
Kd = decay coefficient
u = depth-averaged local velocity
c = c(x,q) the 2-D concentration field

A solution of Equation 2 is:

$$c(\phi,p) = R^1 Ca\,(4\pi\phi)^{-1/2}\left\{\sum_{N=0}^{+\infty}\left[\exp\left\{-\frac{(2n+ps-p)^2}{4\phi}\right\} + \exp\left\{-\frac{(2n+ps+p)^2}{4\phi}\right\}\right] + \sum_{N=1}^{+\infty}\left[\exp\left\{-\frac{(2n-ps-p)^2}{4\phi}\right\} + \exp\left\{-\frac{(2n-ps+p)^2}{4\phi}\right\}\right]\right\} \qquad (3)$$

where

$$\phi = \frac{Dyx}{Q^2}, \quad p = q/Q, \quad p_s = q_s/Q, \quad C_a = \frac{CeQe}{Q}$$

where n = number of images required to account for the effect on concentration of reflection from channel banks
Ce = effluent concentration
Qe = effluent flow rate
Q = discharge of river below outfall
R^1 = exp (-Kdx/U) decay factor

Diffusion Factor

The dimensionless diffusion factor, ϕ, in Equation 3 is a time dependent parameter but since we are considering a steady-state situation, it is directly dependent on the distance downstream from the outfall and can be written as

$$\phi = \beta\,\frac{x}{b}$$

where b = surface width at a transect

The parameter β (BETA) is an input parameter for the mixing zone model and is determined at first by the program MIXANDAT. During the calibration procedure β may be changed to enable predicted concentration distribution to agree with observed data. A more thorough description of this parameter as well as the mathematical basis for the model may be found in Reference 2. The Typical values of β for a shallow river's far field mixing zone are in the range .0001 - .002, however for transects that are relatively close to the outfall, β may be artificially large and may be dependent on the distance, x, from the outfall.

Critical Point Analysis

The boundary of a limited use zone (LUZ) is generally identified by lateral and longitudinal co-ordinates with respect to the outfall. Usually, the lateral boundary of a LUZ is limited to the range 0.2 to 0.4 times the river discharge Q. The cumulative partial discharge between the outfall bank and the accepted lateral boundary will be denoted by the non-dimensional parameter, $P_L = q_L/Q$. A specified pollutant concentration criterion, C_s must be met within q_L. For a given set of values of Ce, Qe, q_L and Q, the longitudinal distribution, $c(x_i, qL)$ predicted by Equation 3 attains a maximum value at some x_i and then follows a decreasing trend as shown in Figure 18. The point at which the concentration attains the maximum value is termed the "critical point". The longitudinal distance between the outfall and the critical point is termed the "critical distance", X_L, and the maximum concentration is termed the "critical concentration", C_L. Detailed description of the method of computation of X_L and C_L are presented by Gowda (1980)(Reference 1).

Knowing C_L and C_s, the allowable effluent concentration, C_{eA}, can be calculated from the following expression:

$$C_{eA} = \frac{C_e\ C_s}{C_L}$$

The maximum longitudinal boundary of LUZ, X_s, occurs along the discharge shoreline in the case of a bank outfall as shown in Figure 1.

APPENDIX B

RELATIONSHIP OF DEPTH, WIDTH AND VELOCITY TO STREAMFLOW

APPENDIX B
RELATIONSHIP OF DEPTH, WIDTH AND VELOCITY TO STREAMFLOW

The streamflow Q, at any stream cross-section is directly related to the cross-sectional area A and the mean velocity by

$$Q = AU \qquad \text{C-1}$$

The area of a cross-section is equal to the product of mean depth H, the mean top width W, and hence

$$Q = HUW \qquad \text{C-2}$$

When the streamflow Q is changed, the width, depth and velocity will be affected. The following general relationships, as developed by Leopold and Maddock may be used to derrive the new H, U and W

$$H = aQ^d \qquad \text{C-3}$$
$$U = bQ^f \qquad \text{C-4}$$
$$W = cQ^g \qquad \text{C-5}$$

Where a, b and c are empirical constants and d, f and g are exponents which are functions of the hydraulic radius, slope and roughness of the channel. It can be shown that by substitution of equations C-3, C-4 and C-5 into C-2, that

$$abc = 1 \qquad \text{C-6}$$
$$d + f + g = 1 \qquad \text{C-7}$$

These equations provide us with a hydraulic model requiring only easily determined empirical exponents (d, f and g). They are extremely useful to estimate the width, depth and velocity of a reach under flow conditions not surveyed.

The Manning equation provides another hydraulic model that requires a knowledge of 3 of 4 parameters; these are velocity V, channel slope S, hydraulic radius R and roughness (η) of the channel

$$V = \frac{R^{2/3}\ S^{1/2}}{n}$$

The Manning equation is accepted as more accurate than the corresponding Leopold-Maddock equation (C-4); in water quality engineering, however, the latter is more commonly used because of its simplicity.

The mixing zone model presented in this manual computes the Leopold-Maddock exponents if surveys are done at different flow conditions by program FLOWCAL.

In the absence of data on a stream under study, Leopold-Maddock coefficients can be derrived by referring to the Manning equation. For a rectangular channel, the Manning equation gives $f = 0.4$, $d = 0.6$ and $g = 0$. In the mixing zone model, the default values of the exponents are $g = 0.05$, $f = 0.45$ and $d = 0.50$.

APPENDIX C

FORTRAN SOURCE CODE

APPENDIX C
Fortran Source Code

1. PREPARE.FOR
2. MIXANDAT.FOR
3. PLTANDAT.FOR
4. MIXCALBN.FOR
5. COMPLOT.FOR
6. MIXAPPLN.FOR
7. PLTCRIT.FOR
8. MIXPRED.FOR
9. MIXCADIF.FOR
10. CONMIX.FOR

```
$DEBUG
C***********************************************************************
C                                                                      *
C                                                                      *
C      PROGRAM PREPARE READS ALL THE INPUT DATA AND MAKES A FILE       *
C      TO BE READ BY THE REST OF THE PROGRAMS.                         *
C      PREPARE ALSO CALCULATES THE TOTAL FLOW FROM VELOCITY            *
C      MEASUREMENTS AND CALCULATES THE LEOPOLD-MADDOCK EXPONENTS       *
C      IF TWO FLOW SITUATIONS ARE MEASURED.                            *
C      WRITTEN BY R. JARVIS                                            *
C      GORE & STORRIE  1986                                            *
C***********************************************************************
      DIMENSION X(10),D(10,30),Y(10,30),C(10,30),ICR(10),V(10,30)
     *,MVEL(10)
      CHARACTER*80 TITLE
      CHARACTER*20 CPARM
      CHARACTER*5 OUTBNK
      OPEN(5,FILE='FIELD.DAT',STATUS='NEW')
      CALL CLRSCN
      WRITE(*,5558)
5558  FORMAT(/'     DATA PREPARATION PROGRAM'/
     1'       ---------------------------'//
     2'                 DATA UNITS'/
     3'         DISTANCE IN METERS'/
     4'         FLOWS IN CUBIC METERS PER SECOND'/
     5'         CONCENTRATIONS IN USER CHOSEN, CONSISTENT UNITS')
      WRITE(*,1)
1     FORMAT(//'    ENTER TITLE OF STUDY'//'        '\)
      READ(*,2)TITLE
2     FORMAT(A)
C
      CALL FLOWCAL(QRS)
C
      CALL CLRSCN
      WRITE(*,3)
3     FORMAT(//'    ENTER FIELD DATA COLLECTED AT RIVER TRANSECTS')
      WRITE(*,4)
4     FORMAT(/'   ENTER NUMBER OF TRANSECTS: '\)
      READ(*,*)NTR
      WRITE(*,5)
5     FORMAT(/'   NAME OF POLLUTANT: '\)
      READ(*,2)CPARM
      WRITE(*,7)
7     FORMAT(/'   FLOW RATE OF EFFLUENT: '\)
      READ(*,*)QEFL
      QRUP=QRS-QEFL
      WRITE(*,8)
8     FORMAT(/'   CONCENTRATION OF EFFLUENT: '\)
      READ(*,*)CEFL
      WRITE(*,9)
9     FORMAT(/'   BACKGROUND CONCENTRATION: '\)
      READ(*,*)CBKG
      WRITE(*,10)
10    FORMAT(/'   BANK OF OUTFALL (RIGHT OR LEFT): '\)
      READ(*,2)OUTBNK
      IF(OUTBNK.EQ.'R'.OR.OUTBNK.EQ.'RI')OUTBNK='RIGHT'
      IF(OUTBNK.EQ.'RIG'.OR.OUTBNK.EQ.'r')OUTBNK='RIGHT'
```

```
      IF(OUTBNK.EQ.'RIGH'.OR.OUTBNK.EQ.'RIGHT')OUTBNK='RIGHT'
      IF(OUTBNK.EQ.'ri'.OR.OUTBNK.EQ.'rig')OUTBNK='RIGHT'
      IF(OUTBNK.EQ.'right'.OR.OUTBNK.EQ.'righ')OUTBNK='RIGHT'
      IF(OUTBNK.EQ.'L'.OR.OUTBNK.EQ.'LE')OUTBNK='LEFT'
      IF(OUTBNK.EQ.'l'.OR.OUTBNK.EQ.'le')OUTBNK='LEFT'
      IF(OUTBNK.EQ.'LEF'.OR.OUTBNK.EQ.'LEFT')OUTBNK='LEFT'
      IF(OUTBNK.EQ.'lef'.OR.OUTBNK.EQ.'left')OUTBNK='LEFT'
      IF(OUTBNK.NE.'RIGHT'.AND.OUTBNK.NE.'LEFT')THEN
      WRITE(*,11)
11    FORMAT(/'   TEMPERATURE OF RIVER: '\)
      READ(*,*)TEMP
      WRITE(*,12)
12    FORMAT(/'   DECAY RATE OF CONTAMINANT IN RIVER: '\)
      READ(*,*)RKS
      WRITE(*,13)
13    FORMAT(/'   TEMPERATURE AT WHICH THIS RATE IS KNOWN: '\)
      READ(*,*)TMP
C
      DO 100 I=1,NTR
      CALL CLRSCN
      WRITE(*,14)I
14    FORMAT(//'    TRANSECT # ',I2/)
      WRITE(*,15)
15    FORMAT(/'   DISTANCE DOWNSTREAM FROM OUTFALL: '\)
      READ(*,*)X(I)
      WRITE(*,300)
300   FORMAT(/'   HOW MANY MEASUREMENTS ACROSS THIS TRANSECT: '\)
      READ(*,*)ICR(I)
      CALL CLRSCN
      WRITE(*,17)OUTBNK
17    FORMAT(/'   ENTER DISTANCE MEASURED FROM ',A,' BANK '/)
      DO 500 J=1,ICR(I)
18    WRITE(*,19)J
19    FORMAT(2X,I2,': '\)
      READ(*,*)Y(I,J)
500   CONTINUE
      CALL CLRSCN
      WRITE(*,21)OUTBNK
21    FORMAT(/'   ENTER DEPTH FROM ',A,' BANK  '/)
      DO 501 J=1,ICR(I)
22    WRITE(*,23)J
23    FORMAT(2X,I2,': '\)
      READ(*,*)D(I,J)
501   CONTINUE
      CALL CLRSCN
104   WRITE(*,25)OUTBNK
25    FORMAT(/'   ENTER CONCENTRATIONS FROM ',A,' BANK  '/)
      DO 502 J=1,ICR(I)
26    WRITE(*,27)J
27    FORMAT(2X,I2,': '\)
      READ(*,*)C(I,J)
502   CONTINUE
      MVEL(I)=0
100   CONTINUE
C
C     NOW WRITE THE DATA INTO THE PROPER FORMAT INPUT FILE
C
```

```
      WRITE(5,2)TITLE
      FEMT=1.
      F1=1.
      F2=.67
      WRITE(5,200)NTR,QEFL,FEMT,F1,F2
 200  FORMAT(2X,I2,2X,F8.3,2X,F6.2,2X,F6.2,2X,F6.2)
      WRITE(5,2)OUTBNK
      DO 201 I=1,NTR
      WRITE(5,202)I
 202  FORMAT('  TRANSECT ',I2)
      WRITE(5,203)
 203  FORMAT('BLANK')
      QRIVER=QRS
      WRITE(5,205)X(I),ICR(I),QRIVER,MVEL(I)
 205  FORMAT(2X,F10.2,2X,I3,2X,F10.3,2X,I2)
      WRITE(5,206)(Y(I,J),J=1,ICR(I))
      WRITE(5,206)(D(I,J),J=1,ICR(I))
      C1=0.
      WRITE(5,900)CPARM
 900  FORMAT(A)
      WRITE(5,*)CBKG,CEFL,C1,C1,C1,C1
      WRITE(5,206)(C(I,J),J=1,ICR(I))
 206  FORMAT(2X,25(1X,F9.2))
      WRITE(5,207)
 207  FORMAT('NOCONC   ')
      WRITE(5,208)
 208  FORMAT(' -999.0 0.0 0.0 0.0 0.0 0.0 0.0 ')
 201  CONTINUE
      CALL CLRSCN
      WRITE(5,5559)CHAR(26)
 5559 FORMAT(A)
      CLOSE(5)
      STOP
      END
C
C
C
C
      SUBROUTINE FLOWCAL(QRS1)
      COMMON/LM/BEX,HEX,UEX
      COMMON/IN/ D(30),Y(30),V(30),DAVE(2),VAVE(2)
      COMMON/QQ/ QRS(2),QAVE(2)
      COMMON/YM/ YMAX(2)
      CALL CLRSCN
      WRITE(*,1)
 1    FORMAT(//'       FLOW CALCULATION PROGRAM')
      WRITE(*,2)
 2    FORMAT('       ~~~~~~~~~~~~~~~~~~~~~~~~')
      WRITE(*,3)
 3    FORMAT(//'  HOW MANY FLOW CONDITIONS SURVEYED  ( 1 OR 2 ) ? :'\)
      READ(*,*)IFL
      WRITE(*,4)
 4    FORMAT(//'  AT HOW MANY TRANSECTS ARE VELOCITY MEASUREMENTS AVAILA
     *BLE ? (1 OR 2) : ')
      WRITE(*,5)
 5    FORMAT(/'  FOR FLOW CONDITION 1 : '\)
      READ(*,*)NTR1
```

```
      IF(IFL.EQ.2)THEN
        WRITE(*,6)
6       FORMAT(/'   FOR FLOW CONDITION 2 : '\)
        READ(*,*)NTR2
      ENDIF
      CALL FLO(1,NTR1,QRS1)
      IF(IFL.EQ.2)CALL FLO(2,NTR2,QRS2)
      IF(IFL.EQ.2)CALL LEOMAD(QRS1,QRS2)
      RETURN
      END
C
C
      SUBROUTINE FLO(JFL,NTR,QRSA)
      COMMON/IN/ D(30),Y(30),V(30),DAVE(2),VAVE(2)
      COMMON/QQ/ QRS(2),QAVE(2)
      COMMON/YM/ YMAX(2)
      DIMENSION QQRS(2)
      DSUM=0.
      VSUM=0.
      II=1
      WRITE(*,10)JFL
10    FORMAT(/'        FLOW CONDITION ',I2)
      DO 99 II=1,NTR
      DSUM=0.
      VSUM=0.
      CALL CLRSCN
      WRITE(*,1)II
1     FORMAT(/'     ENTER THE FOLLOWING DATA FOR TRANSECT ',I2)
      WRITE(*,2)
2     FORMAT('     ---------------------------------------')
      WRITE(*,3)
3     FORMAT(//'     DEPTHS:  HOW MANY MEASUREMENT POINTS ACROSS THE RIVE
     *R ?'\)
      READ(*,*)IDEEP
      WRITE(*,12)
12    FORMAT(/)
      DO 5 I=1,IDEEP
      WRITE(*,6)I
6     FORMAT(' DEPTH ',I2,'       '\)
      READ(*,*)D(I)
5     CONTINUE
      CALL CLRSCN
      WRITE(*,110)IDEEP
110   FORMAT(//'   DISTANCE FROM SHORE OF EACH OF THE ',I2,' POINTS'//)
      DO 11 I=1,IDEEP
      WRITE(*,16)I
16    FORMAT(' DISTANCE ',I2,'     '\)
      READ(*,*)Y(I)
11    CONTINUE
      CALL CLRSCN
      WRITE(*,13)IDEEP
13    FORMAT(//'   ENTER DEPTH AVERAGED VELOCITIES AT THE ',I2,' POINTS'
     *//)
      DO 15 I=1,IDEEP
      WRITE(*,14)I
14    FORMAT('  VELOCITY ',I2,'   '\)
      READ(*,*)V(I)
```

```
15    CONTINUE
      JDEEP=IDEEP-1
      DO 60 I=1,JDEEP
      DSUM=DSUM+(Y(I+1)-Y(I))*(D(I+1)+D(I))/2.
      VSUM=VSUM+(Y(I+1)-Y(I))*(V(I+1)+V(I))/2.
60    CONTINUE
      QQRS(II)=DSUM*VSUM/Y(IDEEP)
      IF(II.EQ.1)THEN
        DAVE(JFL)=DSUM/Y(IDEEP)
        VAVE(JFL)=VSUM/Y(IDEEP)
        YMAX(JFL)=Y(IDEEP)
      ENDIF
      CALL CLRSCN
      WRITE(*,101)JFL
101   FORMAT(/'     FLOW CONDITION : ',I2)
      WRITE(*,100)QQRS(II)
100   FORMAT(/'     TOTAL FLOW IN RIVER =',F10.2)
99    CONTINUE
      IF(NTR.EQ.2)QRSA=(QQRS(1)+QQRS(2))/2.
      IF(NTR.EQ.1)QRSA=QQRS(1)
      WRITE(*,1010)JFL,QRSA
1010  FORMAT(//'    AVERAGE FLOW RATE FOR RIVER
 CONDITION ',I2,'=',F10.
     *3)
      RETURN
      END
C
C
      SUBROUTINE LEOMAD(QRS1,QRS2)
      COMMON/LM/ BEX,HEX,UEX
      COMMON/IN/ D(30),Y(30),V(30),DAVE(2),VAVE(2)
      COMMON/YM/ YMAX(2)
      COMMON/QQ/ QRS(2),QAVE(2)
      QRAT=LOG(QRS1/QRS2)
      DRAT=LOG(DAVE(1)/DAVE(2))
      VRAT=LOG(VAVE(1)/VAVE(2))
      WRAT=LOG(YMAX(1)/YMAX(2))
      BEX=WRAT/QRAT
      HEX=DRAT/QRAT
      UEX=VRAT/QRAT
      WRITE(*,1)
1     FORMAT(/'     LEOPOLD-MADDOCK EXPONENTS')
      WRITE(*,2)BEX
2     FORMAT(/'     WIDTH EXPONENT
 ',F5.3)
      WRITE(*,3)HEX
3     FORMAT(/'     DEPTH EXPONENT
 ',F5.3)
      WRITE(*,4)UEX
4     FORMAT(/' VELOCITY EXPONENT
 ',F5.3)
      RETURN
      END
C
C
C
      SUBROUTINE CLRSCN
```

```
      WRITE(*,101)CHAR(27),'[2J'
101   FORMAT(1X,A,A\)
      RETURN
      END
```

```
$DEBUG
C***********************************************************************
C                                                                      *
C      PROGRAM MIXANDAT.FOR                                            *
C      DATA ANALYSIS PROGRAM FOR MIXING ZONE PACKAGE                   *
C      WRITTEN BY T. P. H. GOWDA                                       *
C      PREPARED FOR USE ON PC BY R. JARVIS                             *
C      GORE & STORRIE  1986                                            *
C                                                                      *
C                                                                      *
C***********************************************************************
       COMMON/A/ X(8),Y(8,60),Z(8,60),VEL(8,60),CONC(8,60)
       COMMON/B/ YL(8,60),ZL(8,60),CONL(8,60),UVL(8,60),VUF(5),VCN(5)
      *,SUMA(60),DVEL(60),DELQ(60),SUMQ(60),DCONC(60),SBF(5)
      *,FLUX(60),DELA(60),SUMF(60),SHF(5)
      *,Q(8),U(8),YW(60),UNIF(60),VCMX(5),SBS(5),SHS(5)
      *,CMX(5),VCQ(5),SBQ(5),SHQ(5),SQQ(5),VPQ(5),ZZAV(25)
       CHARACTER*80 TITLE
       CHARACTER*20 CPARM,TRNSCT
       CHARACTER*10 OUTBNK,REFLD
C
C       DATA INPUT ***
C       DATA IS READ FROM FILE 'FIELD.DAT' WHICH IS FROM PROGRAM 'PREPARE'
C
C       'OUTAN.DAT' IS THE FULL OUTPUT FILE
C
C       'PINCAL.DAT' IS THE INPUT FILE TO MIXCALBN.FOR
C
C       'BETA.DAT' IS THE FILE USED IN SUBROUTINE REGRESS TO CALCULATE
C         THE OVERALL BETA VALUE FOR THE RIVER
C
C       'PLOTAN.DAT' IS THE INPUT FILE FOR PROGRAM PLTANDAT.FOR
C
      OPEN(9,FILE='BETA.DAT',STATUS='NEW')
      OPEN(8,FILE='PLOTAN.DAT',STATUS='NEW')
      OPEN(7,FILE='PINCAL.DAT',STATUS='NEW')
      OPEN(5,FILE='FIELD.DAT',STATUS='OLD')
      OPEN(6,FILE='OUTAN.DAT',STATUS='NEW')
      IP=1
      READ(5,10)TITLE
      WRITE(6,10)TITLE
      WRITE(8,10)TITLE
10    FORMAT(A)
      READ(5,*)NTR,QEFL,FMET,F1,F2
      WRITE(9,2299)NTR
2299  FORMAT(2X,I3)
      READ(5,10)OUTBNK
      WRITE(8,1331)NTR
1331  FORMAT(3X,I2)
      IF(FMET.LE.0.0) FMET=1.0
      IF(F1.LE.0.0) F1=1.0
      IF(F2.LE.0.0) F2=0.67
      QEFL=QEFL*FMET**3
      DO 100 I=1,NTR
      READ(5,10)TRNSCT
      READ(5,10)REFLD
      READ(5,*)X(I),NYZ,Q(I),MVEL
```

```
      READ(5,*)(YL(I,J),J=1,NYZ)
      READ(5,*)(ZL(I,J),J=1,NYZ)
      IF(REFLD.NE.'BLANK') GO TO 38
      IF(OUTBNK.EQ.'LEFT') REFLD='LEFT'
      IF(OUTBNK.EQ.'RIGHT') REFLD='RIGHT'
38    CONTINUE
      X(I)=X(I)*FMET
      Q(I)=Q(I)*FMET**3
      KYZ=NYZ-1
      JP=0
99    READ(5,10)CPARM
      CBKG1=CBKG
      CEFL1=CEFL
      READ(5,*) CBKG,CEFL,FLAGDY,XRNG,CIPT,TCORF
      WRITE(6,20)CPARM,CBKG,CEFL,FLAGDY,XFNG,CIPT,TCORF
20    FORMAT(A,5X,6F10.5)
      IF(CBKG.EQ.-999.0.OR.JP.GE.5)GO TO 150
      JP=JP+1
      READ(5,*)(CONL(I,J),J=1,NYZ)
C
C     EXPRESS DATA W.R.T  ORIGIN AT OUTFALL BANK SIDE OF TRANSECT
C
      CMX(JP)  =-1.0E+10
      DO 130 J=1,NYZ
      IF(OUTBNK.EQ.'LEFT'.AND.REFLD.EQ.'LEFT') GO TO 40
      IF(OUTBNK.EQ.'RIGHT'.AND.REFLD.EQ.'RIGHT') GO TO 40
      K=NYZ-J+1
      GO TO 42
40    K=J
42    CONTINUE
      IF(JP.GE.2) GO TO 120
      Y(I,K)=YL(I,J)*FMET
      YW(K)=Y(I,K)
      Z(I,K)=ZL(I,J)*FMET
      IF(MVEL.EQ.99) VEL(I,K)=UVL(I,J)*FMET
C
C     CALCULATE DYE CONC'NS WHEN FLUORESCENCE VALUES ARE INPUT
C
      IF(FLAGDY.GE.1.)CONL(I,J)=XRNG*(TCORF*CONL(I,J)-CIPT)
120   CONTINUE
      CONC(I,J)=CONL(I,J)
C
C     SET NEGATIVE VALUES TO ZERO
C
      IF(CONC(I,K).LT.0.0) CONC(I,K)=0.0
C
C     FIND PEAK CONC. & ITS POSITION AT TRANSECT.
C
      IF(CMX(JP).GE.CONC(I,K)) GO TO 130
      KP=K
      CMX(JP)=CONC(I,K)
130   CONTINUE
C
      BKFX=CBKG*(Q(I)-QEFL)
      EFLX=CEFL*QEFL
      TFLX=BKFX+EFLX
      IF(I.GT.1)WRITE(6,198)
```

```
 198   FORMAT(1H1/)
       WRITE(6,200)TRNSCT,X(I),JP,CPARM,Q(I),CBKG,QEFL,CEFL,BKFX,EFLX,
      *TFLX
 200   FORMAT(/5X,A,2X,F8.1,' METERS FROM OUTFALL'/10X,'PARAMETER',
      11X,I1,': ',A/5X,'QRIVER=',F9.3,5X,'BACKGROUND CONC.=',F8.3/5X,
      2'QEFL  =',F9.3,5X,'EFFLUENT CONCN.=',F9.3/5X,'UPSTREAM FLUX= ',
      3F10.2,3X,'EFFLUENT FLUX= ',F8.2,3X,'TOTAL FLUX = ',F9.2)
       IF(MVEL.NE.99)WRITE(6,210)
 210   FORMAT(10X,'VELOCITIES SIMULATED FROM RESISTANCE EQN.'/)
       IF(MVEL.EQ.99)WRITE(6,212)
 212   FORMAT(10X,'MEASURED VELOCITIES CORRECTED TO GET Q=SUMQ(NYZ)'/)
       WRITE(6,202)
 202   FORMAT(5X,'Y',6X,'Z',5X,'VEL',5X,'CONC',6X,'SUMA',5X,'SUMQ',
      *5X,'SUMF',4X,'Y/B',4X,'QY/QT',3X,'C/CAVG',3X,'C/CATRN'/)
       IF(JP.GE.2) GO TO 204
C
C  COMPUTE AREA & DISCHARGE.
C
       SUMA(1)=0.
       SUMQ(1)=0.
       DO 22 J=1,KYZ
       JJ=J+1
       DELA(J)=0.5*(Y(I,JJ)-Y(I,J))*(Z(I,JJ)+Z(I,J))
       SUMA(JJ)=SUMA(J)+DELA(J)
       IF(MVEL.NE.99) GO TO 22
       DVEL(J)=0.5*(VEL(I,JJ)+VEL(I,J))
       DELQ(J)=DELA(J)*DVEL(J)
       SUMQ(JJ)=SUMQ(J)+DELQ(J)
 22    CONTINUE
       ZAV=SUMA(NYZ)/Y(I,NYZ)
       ZZAV(I)=ZAV
       IF(MVEL.NE.99) U(I)=Q(I)/SUMA(NYZ)
       IF(MVEL.EQ.99)U(I)=SUMQ(NYZ)/SUMA(NYZ)
C   VELOCITY SIMULATION USING RESISTANCE(EG. MANNING'S) EQN.
       IF(MVEL.EQ.99) GO TO 106
       DO 104 J=1,NYZ
 104   VEL(I,J)=F1*U(I)*(Z(I,J)/ZAV)**F2
C
C  ESTIMATE DISCHARGE FROM SIMULATED VEL. DISTR'N.
C
       SUMQ(1)=0.0
       DO 108 J=1,KYZ
       JJ=J+1
       DVEL(J)=0.5*(VEL(I,JJ)+VEL(I,J))
       DELQ(J)=DELA(J)*DVEL(J)
 108   SUMQ(JJ)=SUMQ(J)+DELQ(J)
 106   CONTINUE
C
C   VELOCITY CORRECTION TO CONFORM WITH SUMQ(NYZ)=Q(I).
C
       DO 109 J=1,NYZ
 109   VEL(I,J)=VEL(I,J)*Q(I)/SUMQ(NYZ)
       SUMQ(1)=0.0
       DO 110 J=1,KYZ
       JJ=J+1
       DVEL(J)=0.5*(VEL(I,JJ)+VEL(I,J))
       DELQ(J)=DELA(J)*DVEL(J)
```

```
110   SUMQ(JJ)=SUMQ(J)+DELQ(J)
      U(I)=SUMQ(NYZ)/SUMA(NYZ)
C
C  SHAPE-VELOCITY FACTOR.
C
      CALL CADIS(Z,VEL,ZAV,U,Q,DELQ,I,NYZ,SHAPE)
C
C   COMPUTE FLUX OF TRACER OR POLLUTANT.
C
204   SUMF(1)=0.
      ARCY=0.
      DO 132 J=1,KYZ
      JJ=J+1
      IF(J.GT.KP.AND.CONC(I,J).LE.0.0)CONC(I,JJ)=0.0
      DCONC(J)=0.5*(CONC(I,JJ)+CONC(I,J))
      DCY=DCONC(J)*(Y(I,JJ)-Y(I,J))
      ARCY=ARCY+DCY
      FLUX(J)=DCONC(J)*DELQ(J)
      SUMF(JJ)=SUMF(J)+FLUX(J)
      UNIF(J)=FLUX(J)/(Y(I,JJ)-Y(I,J))
132   CONTINUE
C
C  COMPUTE AVG. CONC'NS IN RIVER AT OUTFALL & TRANSECT.
C
      CAVG=CEFL*QEFL/Q(I)
      CATRN=SUMF(NYZ)/SUMQ(NYZ)
C
C  PRINT OUTPUT MATRIX OF Y,Z,VEL,SUMQ & SUMF
C
      DO 134 J=1,NYZ
      RYB=Y(I,J)/Y(I,NYZ)
      RQ=SUMQ(J)/SUMQ(NYZ)
      RC=CONC(I,J)/CAVG
      RCTRN=CONC(I,J)/CATRN
      WRITE(8,220)Y(I,J),Z(I,J),VEL(I,J),CONC(I,J),SUMA(J),
     *SUMQ(J),SUMF(J),RYB,RQ,RC,RCTRN
134   WRITE(6,220)Y(I,J),Z(I,J),VEL(I,J),CONC(I,J),SUMA(J),
     *SUMQ(J),SUMF(J),RYB,RQ,RC,RCTRN
220   FORMAT(1X,F7.2,1X,F6.2,2X,F5.2,2X,3(F7.2,2X),F8.2,4(2X,F6.3))
      FXTR=BKFX+SUMF(NYZ)
      WRITE(6,224)CAVG,CATRN,FXTR
224   FORMAT( /5X,'AVG. CONC. JUST BELOW OUTFALL, CAVG=',F8.3/5X,'AVG. C
     1ONC. AT THE TRANSECT, CATRN  =',F8.3,5X,'TOTAL FLUX AT TRANSECT= '
     2,F9.2)
      IF(JP.LE.1)WRITE(6,312) ZAV,U(I),SHAPE
312   FORMAT(5X,'MEAN DEPTH=',F6.3,5X,'MEAN VELOCITY=',F6.3,5X,'SHAPE-VE
     *LOCITY FACTOR=',F6.3)
      IF(JP.LE.1)WRITE(8,1122)ZAV,U(I)
1122  FORMAT(2X,F10.5,3X,F10.5)
C
C       VARIANCE COMPUTATION ***
C   VARIANCE FROM PEAK CONC'N.
C
      RLCN=CMX(JP)/ARCY
      VCMX(JP) =1.0/(6.2836*RLCN*RLCN)
C
C  VARIANCE FROM 2ND MOMENT OF C-Y DISTR'N.
```

```
C
      CALL VARANC(DCONC,NYZ,YW,VCN,ARCY,I,JP,KP,ZAV,SBS,SHS)
C
C  VARIANCE FROM 2ND MOMENT OF UNIT FLUX DISTR'N.
C
      FLXPK=-1.0E+10
      DO 142 J=1,KYZ
      IF(FLXPK.GE.FLUX(J)) GO TO 142
      KF=J
142   CONTINUE
      ARUF=SUMF(NYZ)
      CALL VARANC(UNIF,NYZ,YW,VUF,ARUF,I,JP,KF,ZAV,SBF,SHF)
C
C  VARIANCE OF C-Q DISTRIBUTIONS
C
      CALL VARANC(DCONC,KYZ,SUMQ,VCQ,ARUF,I,JP,KF,ZAV,SBQ,SHQ)
      SQQ(JP)=VCQ(JP)/SUMQ(NYZ)**2
      RLCQ=CMX(JP)/ARUF
      VPQ(JP)=1.0/(6.2836*RLCQ*RLCQ)
      GO TO 99
150   CONTINUE
      WRITE(6,230)TRNSCT
230   FORMAT(/5X,A,': VARIANCE FROM DIFFERENT METHODS:'/4X,'PARAMETER'
     *,4X,'VCMAX',7X,'VCN',8X,'VUF',8X,'VCQ',8X,'VPQ'/)
      DO 102 N=1,JP
      WRITE(6,234) N,VCMX(N),VCN(N),VUF(N),VCQ(N),VPQ(N)
234   FORMAT(7X,I2,3X,5(F10.2,1X))
102   CONTINUE
      RXH=X(I)/ZAV
      RXB=X(I)/Y(I,NYZ)
      WRITE(6,240)RXB,RXH
240   FORMAT(///5X,'NONDIMENSIONAL VARIANCE',5X,'X/B=',F8.2,5X,'X/H=',
     1F9.1//2X,'PARAMETER',4X,'VCN/BB',5X,'VCN/HH',5X,'VUF/BB',5X,
     2'VUF/HH',5X,'VCQ/QQ'/)
      WRITE(9,3032)SBS(IP),SHS(IP),SBF(IP),SHF(IP),SQQ(IP),RXB,RXH
3032  FORMAT(2X,2(F8.4,2X,F9.3,3X),F9.4,2X,F8.4,2X,F10.4)
      DO 100 N=1,JP
      WRITE(6,242)N,SBS(N),SHS(N),SBF(N),SHF(N),SQQ(N)
242   FORMAT(5X,I2,6X,2(F8.4,2X,F9.3,3X),F9.4)
100   CONTINUE
9999  CLOSE(5)
      CLOSE(6)
      CLOSE(9)
      CLOSE(8)
C
C       HERE IS WHERE THE INPUT FILE FOR MIXCALBN IS WRITTEN
C       TO INCAL.DAT
C
      WRITE(7,10)TITLE
      BPWR=0.05
      HPWR=0.5
      UPWR=0.45
      THETA1=1.03
      WRITE(7,9000)Q(1),BPWR,HPWR,UPWR,THETA1
9000  FORMAT(2X,F10.2,2X,F4.2,2X,F4.2,2X,F4.2,2X,F6.3,2X,F7.2,2X,F10.8)
      QRUP=Q(1)-QEFL
      WRITE(7,9001)QRUP,QEFL,CEFL1,CBKG1,TMP1
```

```
9001  FORMAT(2X,F10.2,2X,F10.2,2X,F8.3,2X,F8.3,2X,F8.3)
      IF(OUTBNK.EQ.'RIGHT')QCP=0.
      IF(OUTBNK.EQ.'LEFT')QCP=Q(1)
      NYZ=10
      WRITE(7,9002)NTR,NYZ,QCP
9002  FORMAT(3X,I3,3X,I3,3X,F10.3)
      DO 9004 III=1,NTR
      BS1=Q(1)/(ZZAV(III)*U(III))
      WRITE(7,9003)X(III),BS1,ZZAV(III),U(III)
9003  FORMAT(2X,F10.2,2X,F10.2,2X,F6.2,2X,F6.2)
9004  CONTINUE
C
C
      CLOSE(7)
      CALL REGVAR
      STOP
      END
C
C  COMPUTATION OF SHAPE-VELOCITY FACTOR.
C
      SUBROUTINE CADIS(H,V,HA,VA,QR,DLQ,L,N,SHP)
      DIMENSION H(8,60),V(8,60),QR(8),DLQ(60),VA(8)
      SUMD=0.
      NS=N-1
      DO 12 J=1,NS
      JJ=J+1
      HR=((H(L,JJ)+H(L,J))/HA)**2
      VR=((V(L,JJ)+V(L,J))/VA(L))
      BHUY=DLQ(J)*HR*VR
12    SUMD=SUMD+BHUY
      SHP=SUMD/(8.0*QR(L))
      RETURN
      END
C
C  SUBROUTINE TO COMPUTE VARIANCE VALUES FOR BANK OUTFALL CASE
C
      SUBROUTINE VARANC(P,NY,R,V,SUMD,IC,J,KI,Z,SB,SH)
      DIMENSION P(60),R(60),V(5),SB(5),SH(5)
      SUMN=0.
      K=NY-1
      M=1
10    L=M+1
      IF(M.GT.KI.AND.P(M).LE.0.00011)GO TO 12
      SUMN=SUMN+0.25*P(M)*(R(L)-R(M))*(R(M)+R(L))**2
      IF(M.GE.K)GO TO 12
      M=M+1
      GO TO 10
12    V(J)=SUMN/SUMD
      SB(J)=V(J)/R(NY)**2
      SH(J)=V(J)/Z**2
      RETURN
      END
C
C
C
C     PROGRAM REGVAR.FOR
C     TAKES VALUES COMPUTED BY MIXANDAT.FOR TO DETERMINE IF THE
```

```
C     NONDIMENSIONAL PARAMETER BETA IS DEPTH OR WIDTH DEPENDANT.
C     IT REGRESSES THE VARIOUS VARIANCE ESTIMATES AGAINST WIDTH,
C     DEPTH AND FLOW VARIABLES AND CHOOSES BETA BY CONSIDERING THE
C     EQUATION WITH THE SMALLEST RESIDUAL ERROR.
C
      SUBROUTINE REGVAR
      DIMENSION VCB(20),VCH(20),VUB(20),VUH(20),VCQ(20),B(20),H(20)
     *,Q(20)
      CHARACTER*30 SNAME
      OPEN(5,FILE='OUTVAR.DAT',STATUS='NEW')
      OPEN(6,FILE='BETA.DAT',STATUS='OLD')
      WRITE(5,1)
1     FORMAT('   ENTER THE NUMBER OR TRANSECTS USED:  '\)
      READ(6,*)NTR
      WRITE(5,11)NTR
11    FORMAT(/,I2)
      WRITE(5,2)
2     FORMAT(/'   ENTER THE FOLLOWING VARIANCES AND PARAMETERS'//)
      WRITE(5,3)
3     FORMAT('TRAN      VCN/BB    VCN/HH    VUF/BB    VUF/HH    VCQ/QQ
     *  BB    HH ')
      DO 4 J=1,NTR
      WRITE(5,5)J
5     FORMAT(2X,I2\)
      READ(6,*)VCB(J),VCH(J),VUB(J),VUH(J),VCQ(J),B(J),H(J)
      WRITE(5,102)VCB(J),VCH(J),VUB(J),VUH(J),VCQ(J),B(J),H(J)
102   FORMAT(2X,F7.4,2X,F7.2,2X,F7.4,2X,F7.2,2X,F7.4,2X,F7.3,2X,F7.2)
4     CONTINUE
C
C
      DO 200 KK=1,4
      NNY=NTR-KK+1
      IF(NNY.LE.2)GO TO 200
C
C
      WRITE(5,78)NNY
78    FORMAT(/'  REGRESSION COEFFICIENTS FOR ',I2,' TRANSECTS')
      CALL REGO(VCB,B,RCB,ACB,BCB,NTR,NNY)
      WRITE(5,12)ACB,BCB,RCB
12    FORMAT('    ACB=',F10.5,'   BCB=',F10.5,'    RCB=',F6.4)
      CALL REGO(VCH,H,RCH,ACH,BCH,NTR,NNY)
      WRITE(5,13)ACH,BCH,RCH
13    FORMAT('    ACH=',F10.5,'   BCH=',F10.5,'    RCH=',F6.4)
      CALL REGO(VUB,B,RUB,AUB,BUB,NTR,NNY)
      WRITE(5,14)AUB,BUB,RUB
14    FORMAT('    AUB=',F10.5,'   BUB=',F10.5,'    RUB=',F6.4)
      CALL REGO(VUH,H,RUH,AUH,BUH,NTR,NNY)
      WRITE(5,15)AUH,BUH,RUH
15    FORMAT('    AUH=',F10.5,'   BUH=',F10.5,'    RUH=',F6.4)
      CALL REGO(VCQ,B,RCQ,ACQ,BCQ,NTR,NNY)
      WRITE(5,16)ACQ,BCQ,RCQ
16    FORMAT('    ACQ=',F10.5,'   BCQ=',F10.5,'    RCQ=',F6.4)
200   CONTINUE
C
C
      BETA=BCQ/2.
      WRITE(5,2206)BETA
```

```
      CALL CLRSCN
      WRITE(*,5558)
5558  FORMAT(///)
      WRITE(*,2206)BETA
2206  FORMAT('     THE CALCULATED VALUE OF BETA IS: ',F10.7)
      WRITE(*,9912)
9912  FORMAT(//'     REMEMBER THIS VALUE FOR USE IN THE CALIBRATION PROG
     *RAM       "MIXCALBN"')
C
C
      WRITE(5,9911)CHAR(26)
      WRITE(6,9911)CHAR(26)
9911  FORMAT(A)
      CLOSE(5)
      CLOSE(6)
      RETURN
      END
C
C
C
C
      SUBROUTINE REGO(V,X,R,A,B,N,NNY)
      DIMENSION V(20),X(20)
      SMX=0.
      SMV=0.
      SMXX=0.
      SMVV=0.
      SMXV=0.
      A=0.
      B=0.
      NON=N-NNY+1
      DO 50 I=NON,N
      SMX=SMX+X(I)
      SMV=SMV+V(I)
      SMXX=SMXX+X(I)*X(I)
      SMVV=SMVV+V(I)*V(I)
      SMXV=SMXV+X(I)*V(I)
50    CONTINUE
      B1=SMXV-SMX*SMV/N
      B2=SMXX-SMX*SMX/N
      B=B1/B2
      A=(SMV-B*SMX)/N
      R1=B1
      R2=SQRT(B2)
      R3=SMVV-SMV*SMV/N
      R3=SQRT(R3)
      R=R1/(R2*R3)
      RETURN
      END
C
C
C
      SUBROUTINE CLRSCN
      WRITE(*,101)CHAR(27),'[2J'
101   FORMAT(1X,A,A\)
      RETURN
      END
```

```
$DEBUG
C************************************************************************
C                                                                       *
C     PROGRAM PLTANDAT.FOR                                              *
C                                                                       *
C     PLOTS THE OUTPUT FROM PROGRAM MIXANDAT AND                        *
C     PRODUCES INPUT FILES FOR MIXCALBN.FOR AND MIXCADIF.FOR            *
C     WRITTEN BY R. JARVIS                                              *
C                                                                       *
C     GORE & STORRIE  1986                                              *
C************************************************************************
      COMMON/A/ Y(35,10),Z(35,10),V(35,10),C(35,10),QY(35,10)
      COMMON/B/ A1(35),A2(35),A3(35),A4(35),A5(35),DAVA,VAVA
      COMMON/D/ A1R(35),A2R(35),A3R(35),A4R(35),A5R(35)
      COMMON/C/ DAV(10),VAV(10)
      COMMON/WW/ YQ(35),ZZ(35),VV(35),CC(35)
      COMMON/MAX/ YMAX,ZMAX,CMAX,VMAX
      COMMON/NAME/ TITLE
      INTEGER N(35)
      CHARACTER*20 FILIN
      CHARACTER*80 TITLE
      CHARACTER*30 SNAME
      YMAX=0.
      ZMAX=0.
      CMAX=0.
      VMAX=0.
      OPEN(3,FILE='PLOTOUT.DAT',STATUS='NEW')
      OPEN(5,FILE='PLOTAN.DAT',STATUS='OLD')
      OPEN(6,FILE='SCALE.DAT',STATUS='NEW')
      READ(5,333)TITLE
      WRITE(3,333)TITLE
333   FORMAT(A)
      READ(5,*)NTR
      WRITE(3,525)NTR
525   FORMAT(2X,I2)
      NYZ=10
      WRITE(3,252)NYZ
252   FORMAT(2X,I2)
      DO 2 I=1,NTR
      J=0
      N(I)=0
99    J=J+1
      N(I)=N(I)+1
      READ(5,*)Y(J,I),Z(J,I),V(J,I),C(J,I),D1,D2,D3,D4,QY(J,I)
      IF(Y(J,I).GT.YMAX)YMAX=Y(J,I)
      IF(Z(J,I).GT.ZMAX)ZMAX=Z(J,I)
      IF(C(J,I).GT.CMAX)CMAX=C(J,I)
      IF(V(J,I).GT.VMAX)VMAX=V(J,I)
      IF(QY(J,I).NE.1.0)GO TO 99
      READ(5,*)DAV(I),VAV(I)
2     CONTINUE
      CLOSE(5)
C
      WRITE(*,3)
3     FORMAT(/'   PLOT LOCATION   SCREEN=1  PLOTTER=2  PRINTER=3  '\)
C
      READ(*,*)IPL
```

```
      IF(IPL.EQ.3)CALL PLOTS(0,0,11)
      IF(IPL.EQ.2)CALL PLOTS(0,9600,80)
      IF(IPL.EQ.1)CALL PLOTS(0,0,99)
      DO 8 I=1,35
      A1(I)=0.
      A2(I)=0.
      A3(I)=0.
      A4(I)=0.
      A5(I)=0.
8     CONTINUE
      DO 6 I=1,NTR
      NN=N(I)
      DO 7 J=1,NN
      A1(J)=Y(J,I)
      A2(J)=Z(J,I)
      A3(J)=V(J,I)
      A4(J)=C(J,I)
      A5(J)=QY(J,I)
7     CONTINUE
      DAVA=DAV(I)
      VAVA=VAV(I)
      CALL PLOOT(NN,I,IPL)
      WRITE(6,*)(YQ(J),J=1,11)
6     CONTINUE
      CALL PLOT(0.,0.,999)
900   CONTINUE
      CLOSE(3)
      CLOSE(6)
      STOP
      END
C
C
      SUBROUTINE PLOOT(NN,ITR,IPL)
      COMMON/B/ A1(35),A2(35),A3(35),A4(35),A5(35),DAVA,VAVA
      COMMON/D/ A1R(35),A2R(35),A3R(35),A4R(35),A5R(35)
      COMMON/MAX/ YMAX,ZMAX,CMAX,VMAX
      COMMON/NAME/ TITLE
      COMMON/WW/ YQ(35),ZZ(35),VV(35),CC(35)
      CHARACTER*80 TITLE
      SCY=YMAX/16.
      SCZ=ZMAX/4.
      SCC=CMAX/4.
      SCV=VMAX/4.
      DO 99 J=1,NN
      A2(J)=-A2(J)
99    CONTINUE
      IF(IPL.EQ.3)CALL FACTOR(.25)
      IF(IPL.EQ.2)CALL FACTOR(.25)
      IF(IPL.EQ.1)CALL FACTOR(.2)
      CALL SIMPLX
      CALL STAXIS(.2,.30,.05,.07,1)
C
      CALL PLOT(15.,20.,-3)
      A1(NN+1)=0.
      A1(NN+2)=SCY
      A2(NN+1)=-ZMAX
      A2(NN+2)=SCZ
```

```
      A3(NN+1)=0.
      A3(NN+2)=SCV
      A4(NN+1)=0.
      A4(NN+2)=SCC
      A5(NN+1)=0.
      A5(NN+2)=.2
C
      CALL SYMBOL(-14.5,5.0,.4,TITLE,0.,80)
      CALL SYMBOL(-14.5,4.0,.3,'CROSS-SECTIONAL VALUES FOR TRANSECT',0.,
     *35)
      SITR=FLOAT(ITR)
      CALL NUMBER(-4.0,4.,.3,SITR,0.,-1)
      CALL SYMBOL(-14.5,3.,.3,'( WITH 10 STREAM TUBES )',0.,24)
C
      CALL AXIS(0.,0.,'FLOW FRACTION',13,5.,90.,0.,.2)
      CALL STAXIS(0.,.3,.05,.07,1)
      CALL AXIS(0.,0.,'  ',-2,16.,0.,A1(NN+1),A1(NN+2))
      CALL STAXIS(.2,.3,.05,.07,1)
      CALL COLOR(4,IERR)
      CALL LINE(A1,A5,NN,1,1,1)
      CALL COLOR(0,IERR)
C
      III=1
      DO 939 II=2,11
      F=FLOAT(II-1)/10.
494   IF(F.GT.A5(III))III=III+1
      IF(F.GT.A5(III))GO TO 494
      L=III-1
      Y1=A1(L)
      Y2=A1(III)
      DELY=Y2-Y1
      AAQ=A5(III)-F
      AAAQ=F-A5(L)
      DELQ=AAQ+AAAQ
      YQ(II)=AAAQ*DELY/DELQ+Y1
      SS=YQ(II)/SCY
C
      Z1=A2(L)
      Z2=A2(III)
      DELZ=Z2-Z1
      ZZ(II)=AAAQ*DELZ/DELQ+Z1
      V1=A3(L)
      V2=A3(III)
      DELV=V2-V1
      VV(II)=AAAQ*DELV/DELQ+V1
      C1=A4(L)
      C2=A4(III)
      DELC=C2-C1
      CC(II)=AAAQ*DELC/DELQ+C1
C
      I1=1
      IF(II.EQ.2)WRITE(3,444)I1,A1(1),A2(1),A3(1),A4(1)
      ZZZ=-ZZ(II)
      WRITE(3,444)II,YQ(II),ZZZ,VV(II),CC(II)
444   FORMAT(2X,I2,F7.2,2X,F7.3,2X,F7.3,2X,F7.4)
C
      FF=5.*F
```

```
      CALL STDASH(.2,.2)
      CALL PLOTD(0.,FF,3)
      CALL PLOTD(SS,FF,2)
      CALL PLOTD(SS,0.,2)
      CALL PLOTD(SS,-1.5,3)
      CALL PLOTD(SS,-5.5,2)
      CALL PLOTD(SS,-7.0,3)
      CALL PLOTD(SS,-11.0,2)
      CALL PLOTD(SS,-12.5,3)
      CALL PLOTD(SS,-16.5,2)
939   CONTINUE
C
      CALL PLOT(0.,2.,-3)
      CALL PLOT(-10.,-2.,3)
      CALL PLOT(-10.,-18.,2)
      XST=-10.25
      XEN=-9.75
      DO 9938 IP=1,11
      QQ=FLOAT(IP-1)/10.
      YPL=-18.+1.6*FLOAT(IP-1)
      CALL PLOT(XST,YPL,3)
      CALL PLOT(XEN,YPL,2)
      XNUM=XST-1.0
      XMUN=XEN+.5
      YYQ=YQ(IP)
      CALL NUMBER(XNUM,YPL-.15,.2,QQ,0.,1)
      CALL NUMBER(XMUN,YPL-.15,.2,YYQ,0.,1)
9938  CONTINUE
      CALL SYMBOL(-13.,-14.,.3,'PARTIAL DISCHARGE',90.,17)
      CALL SYMBOL(-7.0,-14.,.3,'LATERAL DISTANCE (M)',90.,20)
      CALL SYMBOL(-14.,-1.0,.3,'STREAM TUBE/DISTANCE SCALE',0.,26)
      CALL PLOT(0.,-2.,-3)
C
      CALL COLOR(0,IER)
      CALL PLOT(0.,-5.5,-3)
      CALL AXIS(0.,0.,'DEPTH',5,4.,90.,A2(NN+1),A2(NN+2))
      CALL STAXIS(0.,.3,.05,.07,1)
      CALL AXIS(0.,0.,'  ',-2,16.,0.,A1(NN+1),A1(NN+2))
      CALL STAXIS(.2,.3,.05,.07,1)
      NNN=NN+2
      CALL COLOR(4,IERR)
      CALL LINE(A1,A2,NN,1,1,1)
      CALL COLOR(0,IERR)
      SCZ=A2(NN+2)
      DA=4.-DAVA/SCZ
      CALL PLOT(0.,DA,3)
      CALL PLOT(17.,DA,2)
      CALL SYMBOL(17.5,DA-.5,.35,'AVE. DEPTH',0.,10)
      CALL NUMBER(17.75,DA,.35,DAVA,0.,2)
C
      CALL PLOT(0.,-5.5,-3)
      CALL AXIS(0.,0.,'VELOCITY',8,4.,90.,A3(NN+1),A3(NN+2))
      CALL STAXIS(0.,.3,.05,.07,1)
      CALL AXIS(0.,0.,'  ',-2,16.,0.,A1(NN+1),A1(NN+2))
      CALL STAXIS(0.2,.3,.05,.07,1)
      CALL COLOR(4,IERR)
      CALL LINE(A1,A3,NN,1,1,1)
```

```
      CALL COLOR(0,IERR)
C
      SCV=A3(NN+2)
      VA=VAVA/SCV
      CALL PLOT(0.,VA,3)
      CALL PLOT(17.,VA,2)
      CALL SYMBOL(17.5,VA-.5,.35,'AVE. VELOCITY',0.,13)
      CALL NUMBER(17.75,VA,.35,VAVA,0.,2)
C
      CALL PLOT(0.,-5.5,-3)
      CALL AXIS(0.,0.,'CONCENTRATION',13,4.,90.,A4(NN+1),A4(NN+2))
      CALL AXIS(0.,0.,'LATERAL DISTANCE Y',-18,16.,0.,A1(NN+1),A1(NN+2))
      CALL COLOR(4,IERR)
      CALL LINE(A1,A4,NN,1,1,1)
      CALL COLOR(0,IERR)
      CALL PLOT(0.,0.,-999)
      RETURN
      END
```

```
$DEBUG
C*********************************************************************
C     PROGRAM NAME MIXCALBN.FOR DEVELOPED FROM MIXCALBN TO RUN ON     *
C     A MICROCOMPUTER                                                 *
C*********************************************************************
C     PROGRAM NAME: MIXCALBN  * * STREAMTUBE MODEL FOR PIPE OUTFALL   *
C     DEVELOPED BY T. P. H. GOWDA, WATER RESOURCES BRANCH, MOE.       *
C     THIS PROGRAM PREDICTS LAT'L & LONG'L DISTRN. OF CONSERVATIVE    *
C     AND NONCONSERVATIVE MATERIALS DISCHARGED INTO A RIVER FROM      *
C     A PIPE OUTFALL LOCATED AT BANK OR IN RIVER(VERT. LINE SOURCE).  *
C     PROGRAM MODIFIED: JUNE 1983  FOR DILUTION FACTOR AND TERMINATE  *
C     CALC'NS IF CONCN < 1.0E-04.                                     *
C                                                                     *
C                                                                     *
C     GORE & STORRIE  1986                                            *
C*********************************************************************
      DIMENSION C(50,102),CUI(50,102)
      REAL*8 X(50),XX(50),P1,P2,P3,P4,T1,T2,T3,T4,RKS(50),QY(502),
     *THETA,BPWR,HPWR,UPWR,QRTO,QT,RBT,QRS,QRUP,QEFL,RBK,CTDP,PHDR,
     *RF(50),BS(50),HS(50),US(50),BETA(50),BW,HW,UW,RKT,R,PHI,TMP,
     *B(50),H(50),U(50),BSUM(50),TOT(50),VOL(50),TEMPS,PAX1,PAX2,
     *A3,QCP,DELQ
      CHARACTER*80 TITLE
      CHARACTER*20 FILIN,FILOUT
C
C     INPUT DATA
C     MIXCALBN READS FILE "PINCAL.DAT" FROM SUBROUTINE SETUP
C     THE FIRST TIME THROUGH AND MAKES FILE "PPINCAL.DAT" TO
C     BE USED ON SUBSEQUENT RUNS.
C
      CALL CLRSCN
      WRITE(*,1290)
1290  FORMAT(/////'     FIRST TIME THROUGH MIXCALBN    1=YES   0=NO')
      READ(*,*)ISET
      IF(ISET.EQ.1)CALL SETUP
      OPEN(5,FILE='PPINCAL.DAT',STATUS='OLD')
      OPEN(4,FILE='CALOUT.DAT',STATUS='NEW')
      OPEN(6,FILE='PLCALPC',STATUS='NEW')
C
C     ICAL IS THE FLAG IN PLCALPC THAT INDICATES A PIPE OUTFALL
C     TO THE PLOTTING PROGRAM CONMIX.FOR
C
      ICAL=1
      WRITE(6,*)ICAL
      WRITE(4,2)
2     FORMAT(/'  ENTER TITLE OF STUDY')
      READ(5,3) TITLE
      WRITE(6,3)TITLE
3     FORMAT(A)
      WRITE(4,3)TITLE
35    WRITE(4,4)
4     FORMAT('   ENTER QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK')
      READ(5,*) QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK
      WRITE(4,400) QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK
400   FORMAT(F7.2,2X,F5.2,2X,F5.2,2X,F4.2,2X,F6.3,2X,F6.2,2X,F4.2)
43    WRITE(4,19)
19    FORMAT('   ENTER DESIGN CASE: QRUP,QEFL,CEFL,CBKG,TMP')
```

```
      READ(5,*)QRUP,QEFL,CEFL,CBKG,TMP
      WRITE(4,401)QRUP,QEFL,CEFL,CBKG,TMP
401   FORMAT(2X,F7.2,2X,F8.3,2X,F8.2,2X,F5.2,2X,F6.2)
33    WRITE(4,5)
5     FORMAT('   ENTER NTR,NYZ,QCP')
      READ(5,*) NTR,NYZ,QCP
      WRITE(6,*)NTR
      WRITE(6,*)NYZ
      WRITE(4,402)NTR,NYZ,QCP
402   FORMAT(2X,I3,3X,I3,F5.1)
      WRITE(4,6)NTR
6     FORMAT('   ENTER ',I2,' VALUES OF X,BS,HS,US')
      READ(5,*) (X(I),BS(I),HS(I),US(I),I=1,NTR)
      READ(5,*)(RKS(I),I=1,NTR)
      DO 405 I=1,NTR
      WRITE(4,403)I,X(I),BS(I),HS(I),US(I)
      WRITE(6,8234)I,X(I)
8234  FORMAT(2X,I3,2X,F8.2)
403   FORMAT(2X,I3,2X,F8.2,3X,F8.2,3X,F6.2,3X,F7.4)
405   CONTINUE
47    WRITE(4,55)NTR
55    FORMAT('   ENTER ',I2,' VALUES OF DECAY')
      DO 408 I=1,NTR
      WRITE(4,406)I,RKS(I)
      WRITE(6,406)I,RKS(I)
406   FORMAT(2X,I3,F9.7)
408   CONTINUE
45    CONTINUE
      WRITE(*,7777)
      WRITE(4,7777)
7777  FORMAT(/'   ENTER VALUES OF BETA'/)
      DO 409 I=1,NTR
      WRITE(*,7778)I
      WRITE(4,7778)I
7778  FORMAT('   TRANSECT ',I3,' : '\)
      READ(*,*)BETA(I)
      WRITE(4,411)BETA(I)
411   FORMAT(5X,F9.7)
      WRITE(6,410)I,BETA(I)
410   FORMAT(2X,I3,F9.7)
409   CONTINUE
      WRITE(4,52)
52    FORMAT('   ARE YOU CONSIDERING UN-IONIZED AMMONIA: YES=1   NO=0')
      READ(5,*) AMONIA,PH
      IF(AMONIA.EQ.0)GO TO 101
      WRITE(4,102)
102   FORMAT('   ENTER THE PH OF UN-IONIZED AMMONIA')
      WRITE(4,412)PH
412   FORMAT('  THE PH OF UN-IONIZED AMMONIA IS   ',F3.1)
101   CONTINUE
C
C  CALCULATE FLOW & TEMP'R PARAMETERS
C
      DELTA=0.0001
      QT=QRUP+QEFL
      QRTO=QT/QRS
      CTDP=THETA**(TMP-TEMPS)
```

```
      RBT=RBK*CTDP
      DELQ=QT/NYZ
      NQ=NYZ+1
      CA=(CEFL*QEFL /QT)
      KCP=QCP/DELQ+1.5
      IF(KCP.LE.1)KCP=KCP+3
      DO 12 I=1,NTR
      BSUM(I)=0.
 12   TOT(I)=0.
      DO 14 I=1,NTR
C
C   CALCULATE B,H,U FOR FLOW=QT, FROM LEOPOLD-MADDOCK EQNS.
C
      B(I)=BS(I)*QRTO**BPWR
      H(I)=HS(I)*QRTO**HPWR
      U(I)=US(I)*QRTO**UPWR
C
C   CALCULATE WEIGHTED MEAN VALUES BW,HW,UW FROM OUTFALL TO TRANSECT(I)
C
      IF(I.GE.2) GO TO 60
      XX(1)=X(1)
      BW=B(1)
      HW=H(1)
      UW=U(1)
      BSUM(1)=B(1)*XX(1)
      VOL(1)=B(1)*H(1)*XX(1)
      TOT(1)=XX(1)/U(1)
      GO TO 62
   60 I1=I-1
      XX(I)=X(I)-X(I1)
      BSUM(I)=BSUM(I1)+0.5*XX(I)*(B(I1)+B(I))
      VOL(I)=VOL(I1)+0.25*XX(I)*(B(I1)+B(I))*(H(I1)+H(I))
      TOT(I)=TOT(I1)+XX(I)/U(I)
      BW=BSUM(I)/X(I)
      HW=VOL(I)/(X(I)*BW)
      UW=QT/(BW*HW)
C
C   CALCULATE PRODUCT FUNCTION FOR DECAY, RF(I).
C
   62 RKT=CTDP*RKS(I)
      CBKX=CBKG*DEXP(-RBT*TOT(I))
      A3=(RKT*XX(I))/U(I)
      R=DEXP(-A3)
      IF(I.GE.2) GO TO 64
      RF(1)=R
      GO TO 66
   64 RF(I)=RF(I1)*R
   66 CONTINUE
      PHI=BETA(I)*X(I)/BW
      PHDR=4.0*PHI
      CRPX=0.5*CA*RF(I)/DSQRT(3.1416*PHI)
      BGX=PHI*ALOG(1./DELTA)
      SBG=SQRT(BGX)
      WRITE(4,40) I,BETA(I),RKS(I)
40    FORMAT(/5X,'TRANSECT: ',I2,2X,'BETA=',F9.6,2X,'RKS=',F9.6,2X,
     */7X,'X',9X,'BW',9X,'HW',8X,'UW')
      WRITE(4,23) X(I),BW,HW,UW
```

```
23    FORMAT(2X,4(F9.3,1X))
      WRITE(4,42)
42    FORMAT(4X,'QY',5X,'C(X,QY)',5X,'CUI',9X,'C/CA',7X,'QY/QT',6X,
     *'DIL FAC'/)
      DO 16 K=1,NQ
      QY(K)=FLOAT(K-1)*DELQ
      IF (QY(K).GT.QT) QY(K)=QT
      PAX1=(QY(K)-QCP)/QT
      PAX2=(QY(K)+QCP)/QT
C
C  DETERMINE NO. OF IMAGES REQUIRED
C
      AN1=(0.5*PAX1-SBG)-0.5
      AN2=(0.5*PAX1+SBG)+0.5
      AN3=-AN2
      AN4=-AN1
      NM1=IFIX(AN1)
      NM2=IFIX(AN2)
      NM3=IFIX(AN3)
      NM4=IFIX(AN4)
      NN1=1+NM2+IABS(NM1)
      NN2=1+IABS(NM3)+IABS(NM4)
      IF(NN1.GE.NN2)NN=NN1+1
      IF(NN1.LT.NN2)NN=NN2+1
C
C  COMPUTATION OF CONC'N DISTR'NS.
C
      SUM=0.
      DO 32 J=1,NN
      N=J-1
      P1=(PAX1-2.*N)**2/PHDR
      P2=(PAX2+2.*N)**2/PHDR
      CALL PDET(P1,T1)
      CALL PDET(P2,T2)
      IF(N.LE.0) GO TO 30
      P3=(PAX1+2.*N)**2/PHDR
      P4=(PAX2-2.*N)**2/PHDR
      CALL PDET(P3,T3)
      CALL PDET(P4,T4)
      GO TO 32
  30  T3=0.
      T4=0.
  32  SUM=SUM+T1+T2+T3+T4
      C(I,K)=CRPX*SUM+CBKX
C
C  CALCULATE UN-IONIZED AMMONIA CONCENTRATIONS*  OPTIONAL *
C
      IF(AMONIA.LE.0) GO TO 15
      PKA=0.09018+2729.92/(TMP+273.2)
      PF=PKA-PH
      PCTU=1./(1.+10.**PF)
      CUI(I,K)=C(I,K)*PCTU
  15  CONTINUE
  16  CONTINUE
      NQQ=NQ
  18  CONTINUE
C
```

```
C  PRINT OUTPUT
C
      DO 20 K=1,NQ
      RC=C(I,K)/CA
      RQ=QY(K)/QT
      CNET=C(I,K)-CBKX
      IF(CNET.LE.0.000009) CNET=-CEFL
      DLF=CEFL/CNET
      IF(AMONIA.LE.0) CUI(I,K)=0.0
      WRITE(6,25)K,QY(K),C(I,K),CUI(I,K),RC,RQ,DLF
20    WRITE(4,25)K,QY(K),C(I,K),CUI(I,K),RC,RQ,DLF
25    FORMAT(I2,2X,F10.2,2X,4(F9.4,2X),F10.2)
14    CONTINUE
999   CLOSE(4)
      CLOSE(5)
      CLOSE(6)
      CALL CLRSCN
      WRITE(*,1234)
1234  FORMAT(//'    THE OUTPUT FILE FROM MIXCALBN.FOR IS CALLED'//'
     *          " CALOUT.DAT "')

      STOP
      END
C
      SUBROUTINE PDET(P,T)
      REAL*8 P,T
      IF(P.GE.40.0)GO TO 10
      T=DEXP(-P)
      GO TO 12
  10  T=0.0
  12  CONTINUE
      RETURN
      END
C
C
      SUBROUTINE SETUP
      DIMENSION RKS(20),BS(20),ZAV(20),VAV(20),X(20),DY(15)
      CHARACTER*80 TITLE
      OPEN(7,FILE='PINCAL.DAT',STATUS='OLD')
      READ(7,1)TITLE
1     FORMAT(A)
      READ(7,*)QRS,BP,HP,UP,THETA
      READ(7,*)QRUP,QEFL,CEFL,CBKG,TMP
      READ(7,*)NTR,NYZ,QCP
      DO 2 I=1,NTR
      READ(7,*)X(I),BS(I),ZAV(I),VAV(I)
2     CONTINUE
      CALL CLRSCN
      WRITE(*,4005)
4005  FORMAT(/'     HYDRODYNAMIC PARAMETER ENTRY AREA'/'     ************
     *************************')
      WRITE(*,3)BP,HP,UP
3     FORMAT(/////'   THE EXPONENTS FOR THE LEOPOLD-MADDOCK EQNS ARE'//
     *'  WIDTH EXP: ',F5.3/'  DEPTH EXP: ',F5.3/'  VEL.  EXP: ',F5.3)
      WRITE(*,4)
4     FORMAT(///'   DO YOU WISH TO CHANGE THEM?   YES=1  NO=0  '\)
      READ(*,*)ICH
```

```
11    IF(ICH.EQ.1)THEN
        WRITE(*,5)
5       FORMAT(/'  WIDTH EXP=  '\)
        READ(*,*)BP
        WRITE(*,6)
6       FORMAT(/'  DEPTH EXP=  '\)
        READ(*,*)HP
        WRITE(*,7)
7       FORMAT(/'  VEL. EXP=   '\)
        READ(*,*)UP
      ENDIF
      CALL CLRSCN
      TOT=BP+HP+UP
      IF(TOT.NE.1.)THEN
         WRITE(*,10)
10       FORMAT(/////'     THE EXPONENTS MUST SUM TO 1.0'/'  RE-ENTER TH
     *EM')
         GO TO 11
      ENDIF
      CALL CLRSCN
      WRITE(*,4004)
4004  FORMAT(//'      DECAY RATE DATA ENTRY AREA',
     */'      ******************************')
C
      WRITE(*,20)
20    FORMAT(///'    ENTER A DECAY RATE FOR THE RIVER BACKGROUND: '\)
      READ(*,*)RBK
C
C
      WRITE(*,4000)
4000  FORMAT(//'   ENTER A DECAY RATE AT EACH TRANSECT '/)
      DO 4001 I=1,NTR
      WRITE(*,4002)I
4002  FORMAT('    TRANSECT ',I2,' : '\)
      READ(*,*)RKS(I)
4001  CONTINUE
C
C
C
C
      WRITE(*,21)
21    FORMAT(/'    AT WHAT TEMPERATURE IS THIS RATE KNOWN? IN C : '\)
      READ(*,*)TEMP
      WRITE(*,22)
22    FORMAT(/'    WHAT IS THE RIVER TEMPERATURE? IN C :  '\)
      READ(*,*)TMP
      CALL CLRSCN
C
      WRITE(*,50)
50    FORMAT(/////'    DO YOU WISH TO CONSIDER AMMONIA?  YES=1  NO=0  '\
     *)
      READ(*,*)IAM
      IF(IAM.EQ.1)THEN
        WRITE(*,51)
51      FORMAT(/'   ENTER PH  '\)
        READ(*,*)PH
      ELSE
```

```
        PH=7.0
      ENDIF
C
      OPEN(7,FILE='PPINCAL.DAT',STATUS='NEW')
      WRITE(7,1)TITLE
      WRITE(7,111)QRS,BP,HP,UP,THETA,TEMP,RBK
111   FORMAT(2X,F9.2,4(2X,F5.3),2X,F6.2,2X,F10.7)
      WRITE(7,112)QRUP,QEFL,CEFL,CBKG,TMP
112   FORMAT(2X,F9.2,2X,F8.2,2X,F8.3,2X,F6.3,2X,F6.2)
      WRITE(7,*)NTR,NYZ,QCP,YOUT
      DO 40 I=1,NTR
      WRITE(7,*)X(I),BS(I),ZAV(I),VAV(I)
40    CONTINUE
      DO 41 I=1,NTR
      WRITE(7,*)RKS(I)
41    CONTINUE
      WRITE(7,*)IAM,PH
      WRITE(7,42)CHAR(26)
42    FORMAT(A)
      CLOSE(7)
      CALL CLRSCN
      RETURN
      END
C
C
C
      SUBROUTINE CLRSCN
      WRITE(*,101)CHAR(27),'[2J'
101   FORMAT(1X,A,A\)
      RETURN
      END
```

```
$DEBUG
C************************************************************************
C                                                                       *
C     PROGRAM COMPLOT.FOR COMPARES THE OBSERVED CONCENTRATIONS         *
C     WITH THOSE CALCULATED BY MIXCALBN.FOR TO ADJUST THE VALUE        *
C     OF BETA                                                          *
C     WRITTEN BY R. JARVIS                                             *
C                                                                       *
C     GORE & STORRIE  1986
C************************************************************************
      COMMON/A/ CO(10,30),YST(10,30),X(20),CP(10,30),BETA(10),SKD(10)
      COMMON/B/ QQY(10,30),CMAX(10),YY(32),CC(32),CD(32),CFACT(10)
      DIMENSION P(4),PP(4),CSAV(10),CSAV2(10),C2SAV(10),C2SAV2(10)
      CHARACTER*70 TITLE1,TITLE3
      CHARACTER*80 TITLE
C
      TITLE1='COMPARISON OF OBSERVED CONCENTRATIONS TO CALIBRATION CONCE
     *NTRATIONS'
      DO 922 I=1,10
      C2SAV(I)=0.
      C2SAV2(I)=0.
      CSAV2(I)=0.
      CSAV(I)=0.
      CMAX(I)=0.0
922   CONTINUE
      CALL CLRSCN
      WRITE(*,801)
801   FORMAT(/////'  HOW DO YOU WANT LATERAL UNITS:  1= STREAM TUBE COOR
     *D.S'
     */'                                 2= REAL DISTANCE IN METERS')
      READ(*,*)IUN
      IF(IUN.EQ.1)TITLE3='LATERAL COORDINATES IN STREAM TUBE UNITS'
      IF(IUN.EQ.2)TITLE3='LATERAL COORDINATES IN REAL UNITS'
C
      OPEN(5,FILE='PLCALPC',STATUS='OLD')
      READ(5,*)ICAL
      READ(5,610)TITLE
610   FORMAT(A)
      READ(5,*)NTR
      READ(5,*)NYZ
      NYZP1=NYZ+1
      DO 79 I=1,NTR
      READ(5,*)ID,XX
79    CONTINUE
      DO 78 I=1,NTR
      READ(5,*)ID,SKD(I)
78    CONTINUE
      DO 77 I=1,NTR
      READ(5,*)ID,BETA(I)
77    CONTINUE
      DO 66 I=1,NTR
      DO 88 J=1,NYZP1
      READ(5,*)ID,QQY(I,J),CO(I,J)
      IF(CO(I,J).GT.CMAX(I))CMAX(I)=CO(I,J)
88    CONTINUE
      DO 1920 J=1,NYZ
      CSAV(I)=CSAV(I)+.1*(CO(I,J+1)+CO(I,J))/2.
```

```
      C2SAV(I)=C2SAV(I)+(.1*FLOAT(J))**2*(CO(I,J+1)+CO(I,J))/2.
1920  CONTINUE
      C2SAV(I)=C2SAV(I)/CSAV(I)
66    CONTINUE
      CLOSE(5)
      OPEN(5,FILE='PLOTOUT.DAT',STATUS='OLD')
      READ(5,610)TITD
      READ(5,*)NTRR
      READ(5,*)NYZZ
      DO 33 I=1,NTR
      DO 44 J=1,NYZP1
      READ(5,*)ID,YST(I,J),D,D,CP(I,J)
      IF(CP(I,J).GT.CMAX(I))CMAX(I)=CP(I,J)
44    CONTINUE
      DO 1902 J=1,NYZ
      CSAV2(I)=CSAV2(I)+.1*(CP(I,J+1)+CP(I,J))/2.
      C2SAV2(I)=C2SAV2(I)+(.1*FLOAT(J))**2*(CP(I,J+1)+CP(I,J))/2.
1902  CONTINUE
      C2SAV2(I)=C2SAV2(I)/CSAV2(I)
33    CONTINUE
      CLOSE(5)
C
      WRITE(*,444)
444   FORMAT('   PLOT LOCATION: SCREEN=1 PLOTTER=2 PRINTER=3  '\)
      READ(*,*)IPL
      IF(IPL.EQ.3)CALL PLOTS(0,0,11)
      IF(IPL.EQ.3)CALL WINDOW(0.,0.,20.,20.)
      IF(IPL.EQ.1)CALL PLOTS(0,0,99)
      IF(IPL.EQ.2)CALL PLOTS(0,9600,80)
      IF(IPL.EQ.2)CALL FACTOR(.16)
      IF(IPL.EQ.1)CALL FACTOR(.13)
      IF(IPL.EQ.3)CALL FACTOR(.15)
      CALL DUPLX
C
C
      CALL SYMBOL(5.,42.,1.,TITLE,0.,80)
      CALL SYMBOL(5.,40.,.75,TITLE1,0.,70)
      CALL SYMBOL(5.,38.,.75,TITLE3,0.,50)
      CALL SYMBOL(5.,36.,.5,'OBSERVED CONCENTRATIONS',0.,23)
      CALL SYMBOL(5.,35.,.5,'PREDICTED CONCENTRATIONS',0.,24)
      P(1)=0.
      P(2)=0.
      PP(1)=0.
      PP(2)=10.
      CALL SCALE(P,2.,2,1)
      CALL SCALE(PP,5.,2,1)
      CALL STDASH(.5,.2)
      CALL PLOT(18.,36.5,-3)
      CALL STLINE(-1,.15,0.)
      CALL COLOR(2,IERR)
      CALL LINE(PP,P,2,1,1,1)
      CALL PLOT(0.,-1.,-3)
      CALL STLINE(+1,.15,0.)
      CALL COLOR(1,IERR)
      CALL LINE(PP,P,2,1,1,1)
      CALL STLINE(+1,.15,0.)
      CALL PLOT(-18.,-35.5,-3)
```

```
      CALL COLOR(0,IERR)
C
      DO 300 I=1,NTR
      CSCALE=CMAX(I)/8.
      DO 400 J=1,NYZP1
      CC(J)=CO(I,J)
      CD(J)=CP(I,J)
      IF(IUN.EQ.2)YY(J)=YST(I,J)
      IF(IUN.EQ.1)YY(J)=FLOAT(J-1)/10.
400   CONTINUE
      CC(NYZP1+1)=0.
      CC(NYZP1+2)=CSCALE
      CD(NYZP1+1)=0.
      CD(NYZP1+2)=CSCALE
      CALL SCALE(YY,10.,NYZP1,1)
      IF(I.EQ.1.OR.I.EQ.5)XOR=2.5
      IF(I.EQ.2.OR.I.EQ.6)XOR=15.0
      IF(I.EQ.3.OR.I.EQ.7)XOR=27.5
      IF(I.EQ.4.OR.I.EQ.8)XOR=40.
      IF(I.GE.1.AND.I.LE.4)YOR=19.5
      IF(I.GE.5.AND.I.LE.8)YOR=2.5
      CALL PLOT(XOR,YOR,-3)
      CALL STAXIS(.3,.5,.10,.3,1)
      IF(IUN.EQ.1) CALL AXIS(0.,0.,'QY/QT',-5,10.,0.,YY(NYZP1+1),YY(NYZP
     *1+2))
      IF(IUN.EQ.2)CALL AXIS(0.,0.,'LATERAL DISTANCE',-16,10.,0.,YY(NYZP1
     *+1),YY(NYZP1+2))
      CALL AXIS(0.,0.,'CONCENTRATION',13,8.,90.,0.,CSCALE)
      CALL STDASH(.5,.2)
      CALL STLINE(+1,.2,0.)
      CALL COLOR(1,IERR)
      CALL LINE(YY,CC,NYZP1,1,1,1)
      CALL STLINE(-1,.2,0.)
      CALL COLOR(2,IERR)
      CALL LINE(YY,CD,NYZP1,1,1,2)
      CALL COLOR(0,IERR)
      CALL SYMBOL(2.0,13.,.5,'TRANSECT', 0.,8)
      SNUM=FLOAT(I)
      CALL NUMBER(6.0,13.,.5,SNUM,0.,-1)
      CALL SYMBOL(0.0,12.,.35,'BETA=',0.,5)
      SNUM=BETA(I)
      CALL NUMBER(2.5,12.,.35,SNUM,0.,5)
      CALL SYMBOL(5.0,12.0,.35,'Kd=',0.,3)
      SNUM=SKD(I)
      CALL NUMBER(6.25,12.0,.35,SNUM,0.,6)
      CALL SYMBOL(4.5,11.,.35,'OBSERVED   PREDICTED',0.,20)
      CALL SYMBOL(0.,10.5,.35,'MEAN CONC.',0.,10)
      CALL SYMBOL(0.,10.,.35,'SPREAD    ',0.,10)
      SNUM=CSAV(I)
      CALL NUMBER(9.5,10.5,.35,SNUM,0.,3)
      SNUM=CSAV2(I)
      CALL NUMBER(4.5,10.5,.35,SNUM,0.,3)
      SNUM=C2SAV(I)
      CALL NUMBER(9.5,10.0,.35,SNUM,0.,3)
      SNUM=C2SAV2(I)
      CALL NUMBER(4.5,10.,.35,SNUM,0.,3)
      CALL PLOT(-XOR,-YOR,-3)
```

```
300   CONTINUE
      CALL PLOT(0.,0.,999)
      STOP
      END
C
C
C
      SUBROUTINE CLRSCN
      WRITE(*,101)CHAR(27),'[2J'
101   FORMAT(1X,A,A\)
      RETURN
      END
```

```
$DEBUG
C***********************************************************************
C     PROGRAM MIXAPPLN.FOR IS THE PC VERSION OF MIXAPPLN               *
C     BY ROB JARVIS                                                    *
C                                                                      *
C     PROGRAM NAME:  MIXAPPLN  * * STREAMTUBE MODEL FOR PIPE OUTFALL   *
C     THIS PROGRAM IS SET UP FOR CONSERVATIVE, NONCONSERVATIVE WITH    *
C     FIRST ORDER DECAY(VIZ.,RESIDUAL CHLORINE, PHENOL, RADIONUCLIDES, *
C     INDICATOR BACTERIA), AND UN-IONIZED AMMONIA CONSTITUENTS.        *
C     THIS PROGRAM INCLUDES OPTIONS FOR DESIGN : QRIVER,QEFFL,TEMP & PH.*
C     PROGRAM DEVELOPED BY T. P. H. GOWDA, WATER RESOURCES BRANCH      *
C     DATE: JUNE 1980.                                                 *
C                                                                      *
C     GORE & STORRIE  1986                                             *
C***********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/A/ C(10,50),CUI(10,50),PH(4)
      COMMON/B/ ARAY1(20,15),ARAY2(20,4),ARAY3(20,4),ARAY4(20,4)
      COMMON/D/ X(10),XX(10),PBK,TBK,PXWC,TXWC,A3,RKS(10),QY(50),QRS,
     1THETA,BPWR,HPWR,UPWR,QRTO,QT,QRUP(6),QEFL(6),CTDP,PHDG,VOL(10),
     2B(10),H(10),U(10),BSUM(10),TOT(10),TMP(6),RQ(11),TEMPS,PAX1,PAX2,
     3RF(10),BS(10),HS(10),US(10),BETA(10),BW(10),HW(10),UW(10),RKT(10),
     4PHI(10),R,QCP,PQX,EY(10),XCRIT,PCRIT,XEK,XMZ,PMZ,TMZ,RBK,RCRT,REK,
     5RXS,RKAV,AWCP,RFWC,XWCP,RBT,RBKG,XSCE,XSCEA,PW1,PW2,QCR,PHWC,DELQ,
     6XL,XEST
      CHARACTER*80 TITLE,PARAM1,PARAM2
      CHARACTER*20 FILIN,FILOUT,POLLU
      CALL CLRSCN
C
      CALL SETUP(JRUN)
C
      OPEN(1,FILE='APINCAL.DAT',STATUS='OLD')
      OPEN(5,FILE='OUTAPP.DAT',STATUS='NEW')
      OPEN(6,FILE='PLAPPLN',STATUS='NEW')
37    WRITE(5,2)
2     FORMAT(/'  ENTER TITLE OF STUDY')
      READ(1,3) TITLE
3     FORMAT(A)
      WRITE(6,*)JRUN
      WRITE(6,3)TITLE
      WRITE(5,3)TITLE
      WRITE(5,1992)
1992  FORMAT(/'  ENTER POLLUTANT NAME')
      READ(1,3)POLLU
      WRITE(6,3)POLLU
      WRITE(5,3)POLLU
      WRITE(5,4)
4     FORMAT('  ENTER QRS,BPWR,HPWR,UPWR,TEMPS,NTR')
      READ(1,*) QRS,BPWR,HPWR,UPWR,TEMPS,NTR
      WRITE(5,901)QRS,BPWR,HPWR,UPWR,TEMPS,NTR
901   FORMAT(3X,F7.1,4X,F5.1,4X,F5.2,4X,F5.2,F5.1,2X,I2)
      WRITE(6,*)NTR
      WRITE(5,6)
6     FORMAT('  ENTER NTR VALUES OF X,BS,HS,US')
      DO 15 I=1,NTR
      READ(1,*) X(I),BS(I),HS(I),US(I)
      WRITE(5,902)X(I),BS(I),HS(I),US(I)
```

```
15    WRITE(6,902)X(I),BS(I),HS(I),US(I)
902   FORMAT(3X,F7.1,3X,F7.1,3X,F6.2,3X,F6.3)
      WRITE(5,8)
8     FORMAT('  ENTER NTR VALUES OF BETA')
      READ(1,*) (BETA(I),I=1,NTR)
      DO 904 I=1,NTR
      WRITE(5,903)BETA(I)
903   FORMAT(3X,F8.5)
904   CONTINUE
      WRITE(5,80)
80    FORMAT('  ENTER MQ & QRUP VALUES')
      READ(1,*) MQ,(QRUP(J),J=1,MQ)
      DO 906 I=1,MQ
      WRITE(5,907)I,QRUP(I)
907   FORMAT('     QRUP(',I4,')=',F9.2)
906   CONTINUE
      WRITE(6,*)MQ,(QRUP(I),I=1,MQ)
      WRITE(5,82)
82    FORMAT('  ENTER MT & TEMP VALUES')
      READ(1,*)MT,(TMP(L),L=1,MT)
      DO 908 L=1,MT
      WRITE(5,909)L,TMP(L)
909   FORMAT('     TMP(',I3,')=',F6.1)
908   CONTINUE
      WRITE(6,*)MT,(TMP(I),I=1,MT)
      WRITE(5,86)
86    FORMAT('  ENTER MF & QELF VALUES')
      READ(1,*) MF,(QEFL(L),L=1,MF)
      DO 910 L=1,MF
      WRITE(5,911)L,QEFL(L)
911   FORMAT('     QEFL(',I2,')=',F6.2)
910   CONTINUE
      WRITE(6,*)MF,(QEFL(I),I=1,MF)
35    WRITE(5,52)
52    FORMAT('  UN-IONIZED AMMONIA: ENTER 1 FOR YES
 0 FOR NO')
      READ(1,*) AMONIA
      WRITE(5,912)AMONIA
912   FORMAT('   AMONIA=',F2.0)
      IF(AMONIA.LE.-888.8) GO TO 888
      IF(AMONIA.LE.0)GO TO 70
      WRITE(5,57)
57    FORMAT('  ENTER MPH AND PH VALUES')
      READ(1,*)MPH,(PH(JPH),JPH=1,MPH)
      DO 914 JJ=1,MPH
      WRITE(5,913)JJ,PH(JJ)
913   FORMAT('  PH(',I2,')=',F7.3)
914   CONTINUE
      WRITE(6,*)MPH,(PH(I),I=1,MPH)
70    CONTINUE
      WRITE(5,56)
56    FORMAT('  ENTER QCP,CEFL,CBKG,CS,THETA,RBK,XWCP')
      READ(1,*)QCP,CEFL,CBKG,CS,THETA,RBK,XWCP
      WRITE(5,915)QCP,CEFL,CBKG,CS,THETA,RBK,XWCP
      WRITE(6,915)QCP,CEFL,CBKG,CS,THETA,RBK,XWCP
915   FORMAT(2X,F5.2,3X,F9.2,3X,F6.2,3X,F7.2,3X,F5.2,3X,F5.2,F8.1)
      WRITE(5,55)
```

```
 55    FORMAT('  ENTER NTR VALUES OF RKS')
       READ(I,*) (RKS(I),I=1,NTR)
       DO 916 I=1,NTR
       WRITE(5,917)I,RKS(I)
 917   FORMAT(2X,'RKS(',I2,')=',F8.6)
 916   CONTINUE
       WRITE(6,*)(RKS(I),I=1,NTR)
C
C   CALCULATE FLOW & TEMP'R SCALE-UP PARAMETERS
C      DELTA=0.0001
    ALOG(1/DELTA)=(4.0*2.3026) FOR CALCN. OF BGX
C
       NQR=11
       NW=5
       DO 10 L=1,NQR
 10    RQ(L)=(L-1)/10.0
       WRITE(5,24) TITLE
 24    FORMAT(1H1/////6X,'PREDICTIONS OF RUNS FOR MANAGEMENT OPTIONS'/A)
C
C      BEGIN COMPUTATIONS FOR THE INPUT OPTIONS.
C
       DO 20 JF=1,MF
       DO 20 JQ=1,MQ
       QT=QRUP(JQ)+QEFL(JF)
       DELQ=QT/(NQR-1)
       QRTO=QT/QRS
       CA=(CEFL*QEFL(JF)/QT)
       DO 20 JT=1,MT
       CTDP=THETA**(TMP(JT)-TEMPS)
       RBT=RBK*CTDP
       IF(AMONIA.LE.0)MPH=1
       DO 20 JPH=1,MPH
       IRUN=IRUN+1
       IR=IRUN
       IF(AMONIA.LE.0)PH(JPH)=7.0
       ARAY1(IR,1)=IRUN
       ARAY1(IR,2)=QEFL(JF)
       ARAY1(IR,3)=QRUP(JQ)
       ARAY1(IR,4)=TMP(JT)
       ARAY1(IR,5)=PH(JPH)
       ARAY1(IR,12)=CS
       ARAY1(IR,15)=CA
       WRITE(5,92)IRUN
 92    FORMAT(/'  * * RUN NO.: ',I4)
C
C      CALCULATE AMMONIA IONIZATION PARAMETER
C
       IF(AMONIA.LE.0) GO TO 34
       PKA=0.09018+2729.92/(TMP(JT)+273.2)
       PF=PKA-PH(JPH)
       PCTU=1./(1.+10.**PF)
       CSTTL=CS/PCTU
 34    WRITE(5,88)QEFL(JF),QRUP(JQ),TMP(JT),PH(JPH),CEFL,CS
 88    FORMAT(2X,'QEFL=',F8.3,2X,'QRUP=',F10.3,2X,'TEMPR=',F4.1,2X,'PH=',
      1F4.1,/2X,'CEFL=',F8.2,2X,'CS=',F5.2)
       IF(AMONIA.GE.1)WRITE(5,54)CSTTL
 54    FORMAT(5X,'    CRITERION FOR TOTAL AMMONIA, CS=',F6.3)
```

```
      WRITE(5,90) (RQ(L),L=1,NW)
90    FORMAT(/6X,'X',6X,'EY',7X,5(F3.1,6X),//)
      DO 12 I=1,NTR
      BSUM(I)=0.
      VOL(I)=0.0
12    TOT(I)=0.
C
C     BEGIN COMPUTATIONS AT TRANSECT,I.
C
      DO 14 I=1,NTR
C
C   CALCULATE B,H,U FOR DESIGN FLOW=QT, FROM LEOPOLD-MADDOCK EQNS.
C
      B(I)=BS(I)*QRTO**BPWR
      H(I)=HS(I)*QRTO**HPWR
      U(I)=US(I)*QRTO**UPWR
C
C   CALCULATE WEIGHTED MEAN VALUES BW,HW,UW FROM OUTFALL TO TRANSECT(I)
C
      IF(I.GE.2) GO TO 60
      XX(1)=X(1)
      BW(1)=B(1)
      HW(1)=H(1)
      UW(1)=U(1)
      BSUM(1)=B(1)*XX(1)
      VOL(1)=XX(1)*B(1)*H(1)
      TOT(1)=XX(1)/U(1)
      GO TO 62
60    I1=I-1
      XX(I)=X(I)-X(I1)
      BSUM(I)=BSUM(I1)+0.5*XX(I)*(B(I1)+B(I))
      VOL(I)=VOL(I1)+0.25*XX(I)*(B(I1)+B(I))*(H(I1)+H(I))
      TOT(I)=TOT(I1)+XX(I)/U(I)
      BW(I)=BSUM(I)/X(I)
      HW(I)=VOL(I)/(X(I)*BW(I))
      UW(I)=QT/(BW(I)*HW(I))
C
C   CALCULATE PRODUCT FUNCTION FOR DECAY, RF(I), & DISPERSION FACTOR
C
62    RKT(I)=CTDP*RKS(I)
      PBK=RBT*TOT(I)
      CALL PDET(PBK,TBK)
      CBKX=CBKG*TBK
      A3=(RKT(I)*XX(I))/U(I)
      R=DEXP(-A3)
      IF(I.GE.2) GO TO 64
      RF(1)=R
      GO TO 66
64    RF(I)=RF(I1)*R
66    EY(I)=BETA(I)*B(I)*U(I)
      PHI(I)=BETA(I)*X(I)/BW(I)
      PHDG=4.0*PHI(I)
      CMAX=0.5*CA*RF(I)/DSQRT(3.1416*PHI(I))
C
C  LATERAL CONC. DISTR'N AT TRANSECT,I.
C
      DO 16 K=1,NW
```

```
      QY(K)=(K-1)*DELQ
      IF (QY(K).GT.QT) QY(K)=QT
      PAX1=(QY(K)-QCP)/QT
      PAX2=(QY(K)+QCP)/QT
      CALL SUMSRS(PAX1,PAX2,PHDG,SUMT)
      C(I,K)=CMAX*SUMT+CBKX
16    CONTINUE
      WRITE(5,25) X(I),EY(I),(C(I,K),K=1,NW)
25    FORMAT(2X,F8.1,1X,F8.3,11F9.3)
14    CONTINUE
C
C  UN-IONIZED AMMONIA CONCENTRATION DISTRN.
C
      IF(AMONIA.LE.0)GO TO 191
      WRITE(5,26)
26    FORMAT(2X,'TOXIC AMMONIA')
      DO 19 I=1,NTR
      DO 17 K=1,NW
      CUI(I,K)=C(I,K)*PCTU
17    CONTINUE
      WRITE(5,25) X(I),EY(I),(CUI(I,K),K=1,NW)
19    CONTINUE
191   CONTINUE
C
C     END OF COMPUTATIONS AT TRANSECT,I.
C
      IF(AMONIA.LE.0)CSL=CS
      IF(AMONIA.GE.1)CSL=CSTTL
C
C     COMPUTE BACKGROUND AVG. CONC. AT D/S WPCP.
C
      RKAV=-DLOG(RF(NTR))/TOT(NTR)
      AWCP=RKAV*XWCP/UW(NTR)
      CALL PDET(AWCP,RFWC)
      CBA=CA*RFWC
76    PXWC=RBT*XWCP/UW(NTR)
      CALL PDET(PXWC,TXWC)
      CBB=CBKG*TXWC
      CAWP=CBA+CBB
C     COMPUTE BANK CONC. AT D/S WPCP.
      PW1=0.
      PW2=0.
      PHWC=4.0*BETA(NTR)*XWCP/BW(NTR)
      CALL SUMSRS(PW1,PW2,PHWC,SUMWC)
      CWCP=CBA*SUMWC/DSQRT(3.1416*PHWC)+CBB
C
C  COMPUTATIONS FOR MIXING ZONE PARAMETERS
C
      XMZ=B(NTR)/BETA(NTR)
      PMZ=RKAV*XMZ/UW(NTR)
      CALL PDET(PMZ,TMZ)
      CMZ=CA*TMZ
C
C     CALCULATE XSCE
C
      IF(CWCP.GT.CSL) GOTO 220
      CALL PARSPR(C,CSL,X,NTR,KXS,XEST,CXS)
```

```
      RXS=-DLOG(RF(KXS))/TOT(KXS)
      CALL SPREAD(CSL,CA,CBKG,RBT,CXS,XEST,XSCE,KXS,BW,RXS,UW,BETA)
      GO TO 222
220   XSCE=-999.0
      ITRN=0
222   WRITE(5,50)XSCE,XMZ,CMZ,XWCP,CWCP,CAWP
      WRITE(6,*)XMZ
50    FORMAT(/5X,'XS (WITH CE)=',F10.1,/5X,
     *'MIXING ZONE LENGTH=',F9.1,5X,'CONC=',F8.2/5X,'DIST. TO D/S WPCP='
     *,F8.1,5X,'SHORE CONC. AT D/S WPCP=',F6.2/8X,'AVG. CONC. AT D/S WPC
     *P= ',F6.2)
      ARAY1(IR,6)=CAWP
      ARAY1(IR,7)=XSCE
C
C  CRITICAL POINT RESULTS FOR QRATIO=0.1 , 0.2 & 0.3
C
      WRITE(5,94)
94    FORMAT(/9X,'     CRITICAL POINT METHOD RESULTS '/9X,'QY/QT',6X,
     *'XL',8X,'CL',9X,'CEA',6X,'XSCEA')
      DO 20 K=2,5
      KK=K-1
      CCRIT=-1.0D+10
C
C  SEARCH FOR TRANSECT NEAR WHICH CRIT. CONC. OCCURS TO FIND MOVING
C     AVG. VALUES FOR CRITICAL POINT COMPUTATIONS
C
      DO 18 I=1,NTR
      IF(CCRIT.GE.C(I,K)) GO TO 18
      ICR=I
      CCRIT=C(I,K)
18    CONTINUE
      XCRIT=X(ICR)
      PCRIT=PHI(ICR)
      RCRT=-DLOG(RF(ICR))/TOT(ICR)
C
C   CALCULATE XL,CL & CEA BY CRIT. POINT METHOD USING MOVING AVG. VALUES
C
40    QCR=4.0*RCRT*XCRIT/(PCRIT*UW(ICR))*(QY(K)/QT)**2
      IF(RF(ICR).EQ.1.0)GO TO 9007
      XL=0.25*UW(ICR)*(-1.0+DSQRT(1.+QCR))/RCRT
      GO TO 9008
9007  XL=.5*XCRIT*QY(K)**2/(PCRIT*QT**2)
9008  XLDIF=DABS(XL-XCRIT)
      XPCT=100.*XLDIF/XL
      IF(XPCT.LE.5.) GO TO 42
      XCRIT=XL
      PCRIT=BETA(ICR)*XL/BW(ICR)
      GO TO 40
42    PQX=(RCRT*XL/UW(ICR))+(0.25/PCRIT*(QY(K)/QT)**2)
      IF(RF(ICR).EQ.1.0)GO TO 9010
      CL=(CA/DSQRT(3.1416*PCRIT))*DEXP(-PQX)+CBKG*DEXP(-RBT*XL/UW(ICR))
      GO TO 9011
9010  CL=CA*QT/(QY(K)*2.07)
9011  CEA=CEFL*CSL/CL
C
C     COMPUTE XSCEA
C
```

```
      IF(CWCP.GT.CL)GO TO 114
      CALL PARSPR(C,CL,X,NTR,IEK,XEK,CXK)
      REK=-DLOG(RF(IEK))/TOT(IEK)
      CALL SPREAD(CL,CA,CBKG,RBT,CXK,XEK,XSCEA,IEK,BW,REK,UW,BETA)
      GO TO 116
114   XSCEA=-999.0
      ITRA=0
116   WRITE(5,96)RQ(K),XL,CL,CEA,XSCEA
      WRITE(6,996)XL,CL
996   FORMAT(2X,F8.1,2X,F8.3)
96    FORMAT(9X,F4.2,2X,F8.1,2X,F8.3,4X,F8.2,3X,F8.1)
C
C     STORE OUTPUT IN ARRAYS
C
      GO TO (45,46,47,477),KK
45    ARAY1(IR,8)=RQ(2)
      ARAY1(IR,9)=CEA
      ARAY1(IR,10)=XSCEA
      GO TO 20
46    ARAY2(IR,1)=RQ(3)
      ARAY2(IR,2)=CEA
      ARAY2(IR,3)=XSCEA
      GO TO 20
47    ARAY3(IR,1)=RQ(4)
      ARAY3(IR,2)=CEA
      ARAY3(IR,3)=XSCEA
      GO TO 20
477   ARAY4(IR,1)=RQ(5)
      ARAY4(IR,2)=CEA
      ARAY4(IR,3)=XSCEA
20    CONTINUE
C      WRITE(6,*)MZL
888   CONTINUE
      WRITE(5,138)
138   FORMAT(1H,//)
      WRITE(5,78)TITLE
78    FORMAT(1H1//6X,'SUMMARY OF RUNS FOR MANAGEMENT OPTIONS'/A)
      WRITE(5,100)
100   FORMAT(//1X,'RUN #',2X,'QEFL',5X,'QRUP',3X,'TEMP',3X,'PH',4X,
     *'CAWP',3X,'XSCE',4X,'QY/QT',4X,'CEA',4X,'XSCEA'
     *,5X,'CBKG',4X,'CSIJC',5X,'CBIOT',4X,'CDRNK',4X,'CDILN',//)
      DO 48 N=1,IR
      WRITE(5,102)(ARAY1(N,J),J=1,15)
102   FORMAT(1X,F4.0,1X,F7.3,1X,F7.1,2X,2F5.1,1X,F7.3,
     *1X,F7.1,2X,F4.2,2X,F8.2,1X,F8.1,2X,F6.2,3(2X,F7.1),3X,F7.3)
      WRITE(5,104)(ARAY2(N,J),J=1,3)
104   FORMAT(51X,F4.2,2X,F8.2,1X,F8.1)
      WRITE(5,104)(ARAY3(N,J),J=1,3)
48    WRITE(5,104)(ARAY4(N,J),J=1,3)
      WRITE(5,9) PARAM1
9     FORMAT(//1X,A)
      IF(NPARM.GE.7) WRITE(5,3) PARAM2
      WRITE(5,138)
      CLOSE(1)
999   CLOSE(1)
      WRITE(5,5558)CHAR(26)
5558  FORMAT(A)
```

```
      WRITE(5,5558)CHAR(26)
      CLOSE(5)
      CLOSE(6)
      WRITE(*,1092)
1092  FORMAT(//'  THE OUTPUT FILE FROM PROGRAM MIXAPPLN IS'/'  "OUTAPP.D
     *AT"')
      STOP
      END
C
C  SUBROUTINE FOR SUMMATION OF EXPONENTIAL SERIES TERMS.
C
      SUBROUTINE SUMSRS(QAX1,QAX2,PFDR,SUM)
      IMPLICIT REAL*8 (A-H,O-Z)
      BGX=2.3026*PFDR
      SBG=DSQRT(BGX)
C
C  DETERMINE NO. OF IMAGES REQUIRED
C
      AN1=(0.5*QAX1-SBG)-0.5
      AN2=(0.5*QAX1+SBG)+0.5
      AN3=-AN2
      AN4=-AN1
      NM1=IDINT(AN1)
      NM2=IDINT(AN2)
      NM3=IDINT(AN3)
      NM4=IDINT(AN4)
      NN1=1+NM2+IABS(NM1)
      NN2=1+IABS(NM3)+IABS(NM4)
      IF(NN1.GE.NN2)NN=NN1+1
      IF(NN1.LT.NN2)NN=NN2+1
C
C   COMPUTE SUM OF EXPONENTIAL SERIES TERMS
C
      SUM=0.
      DO 32 J=1,NN
      N=J-1
      P1=(QAX1-2.*N)**2/PFDR
      P2=(QAX2+2.*N)**2/PFDR
      CALL PDET(P1,T1)
      CALL PDET(P2,T2)
      IF(N.LE.0) GO TO 30
      P3=(QAX1+2.*N)**2/PFDR
      P4=(QAX2-2.*N)**2/PFDR
      CALL PDET(P3,T3)
      CALL PDET(P4,T4)
      GO TO 32
   30 T3=0.
      T4=0.
   32 SUM=SUM+T1+T2+T3+T4
      RETURN
      END
C
C  COMPUTE EXPONENTIAL TERMS: SET (P.LE.40.0) TO AVOID ERROR 208, SO
C    THAT EXP(-P)=4.3E-18.
C
      SUBROUTINE PDET(P,T)
      IMPLICIT REAL*8 (A-H,O-Z)
```

```
      IF(P.GE.40.)GO TO 10
      T=DEXP(-P)
      GO TO 12
   10 T=0.0
   12 CONTINUE
      RETURN
      END
C
C  COMPUTE PARAMETERS IN THE SUBROUTINE 'SPREAD'.
C
      SUBROUTINE PARSPR(C,CL,X,NTR,IEK,XEK,CXK)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION C(1,1),X(1)
      XEK=0.
      IF(C(NTR,1).GE.CL) GO TO 75
      DO 72 I=2,NTR
      II=I-1
      IF(C(1,1).LE.CL)GO TO 73
      IF(C(II,1).GT.CL.AND.C(I,1).LE.CL) GO TO 73
   72 CONTINUE
   73 IEK=II
      GO TO 79
   75 IEK=NTR
   79 XEK=X(IEK)
      CXK=C(IEK,1)
      RETURN
      END
C
C   COMPUTATION OF MAX. LONGL. SPREAD XS ALONG OUTFALL BANK WHERE
C   (C(XS,0)-CS)=5 PERCENT(ABSOLUTE).
C
      SUBROUTINE SPREAD(CST,CAV,CBG,RB,CXY,XEY,XST,M,BI,RS,US,BTA)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION BI(1),BTA(1),US(1)
      CXX=CXY
      XS=XEY
      IT=0
   18 IT=IT+1
      DIFF=(CXX-CST)
      RCAB=DABS(DIFF/CST)
      PRCNT=100.*RCAB
      IF(PRCNT.LE.5.)GO TO 26
      IF(IT.GT.30) GO TO 27
      FRX=RCAB/(1.0+PS)
      IF(DIFF.LE.0.0) XS=XS*(1-FRX)
      IF(DIFF.GT.0.0) XS=XS*(1+FRX)
      PHB=4.0*BTA(M)*XS/BI(M)
      PS=RS*XS/US(M)
      CALL PDET(PS,TS)
      CMM=CAV*TS/DSQRT(3.1416*PHB)
      PX1=0.
      PX2=0.
      PG=RB*XS/US(M)
      CALL PDET(PG,TG)
      CALL SUMSRS(PX1,PX2,PHB,SUMP)
      CXX=CMM*SUMP+CBG*TG
      GO TO 18
```

```
  27  XS=-888.0
  26  XST=XS
      RETURN
      END
C
C     SUBROUTINE SETUP READS A RAW INPUT FILE AND ASKS THE USER FOR
C     ADDITIONAL INFORMATION AND WRITES ALL THE DATA IN A FILE
C     APINCAL.DAT TO BE READ BY THE MAIN OF MIXAPPLN.FOR
C
      SUBROUTINE SETUP(IRUN)
      DIMENSION X(10),BS(10),HS(10),US(10),QRUP(10),QEFL(10),TMP(10)
     *,PH(10),BETA(10),RKS(10),CFACT(10)
      CHARACTER*80 TITLE,CONNAME
      CHARACTER*20 POLLU
      CHARACTER*2 PPP
      OPEN(5,FILE='PINCAL.DAT',STATUS='OLD')
      IRUN=0
      READ(5,1)TITLE
1     FORMAT(A)
      READ(5,*)QRS,BPWR,HPWR,UPWR,THETA
      READ(5,*)QRUP1,QEFL1,CEFL,CBKG,TEMP
      READ(5,*)NTR,NYZ,QCP
      DO 3 I=1,NTR
      READ(5,*)X(I),BS(I),HS(I),US(I)
3     CONTINUE
      CLOSE(5)
      CALL CLRSCN
      WRITE(*,4)
4     FORMAT(/'          SUMMARY OF INPUT DATA')
      WRITE(*,5)
5     FORMAT('          *********************')
      WRITE(*,12)
12    FORMAT(//'          REFERENCE RIVER PARAMETERS'//)
      WRITE(*,11)QRS
11    FORMAT(/'   TOTAL RIVER FLOW BELOW OUTFALL AT TIME OF SURVEY : ',F
     *10.3)
      WRITE(*,13)
13    FORMAT(/'   TRANSECT DISTANCE',5X,'RIVER WIDTH',5X,'AVERAGE DEPTH'
     *,5X,'AVERAGE VELOCITY')
      DO 100 I=1,NTR
      WRITE(*,14)X(I),BS(I),HS(I),US(I)
14    FORMAT(6X,F10.2,8X,F8.2,12X,F6.2,11X,F6.2)
100   CONTINUE
      WRITE(*,15)
15    FORMAT(/'   NOW YOU MAY ENTER DESIGN PARAMETERS'/' STRIKE  [ENTER]
     * TO CONTINUE'\)
      READ(*,1)PPP
      CALL CLRSCN
      WRITE(*,10)
10    FORMAT(/'   ENTER STUDY TITLE : '\)
      READ(*,1)CONNAME
      WRITE(*,1293)
1293  FORMAT(/'   ENTER POLLUTANT NAME : '\)
      READ(*,1)POLLU
C
      CALL CLRSCN
      WRITE(*,6)
```

```
 6     FORMAT(/'  ENTER # OF UPSTREAM FLOW RATES (<9) : '\)
       READ(*,*)IFR
       WRITE(*,16)
 16    FORMAT(/'  ENTER THESE FLOW RATES')
       DO 101 I=1,IFR
       WRITE(*,17)I
 17    FORMAT(10X/' RATE ',I2,':  '\)
       READ(*,*)QRUP(I)
 101   CONTINUE
 C
       CALL CLRSCN
       WRITE(*,7)
 7     FORMAT(//'  ENTER # OF EFFLUENT FLOW RATES (<7) : '\)
       READ(*,*)IEFL
       WRITE(*,18)
 18    FORMAT(/'  ENTER THESE FLOW RATES')
       DO 102 I=1,IEFL
       WRITE(*,19)I
 19    FORMAT(10X/' RATE ',I2,':  '\)
       READ(*,*)QEFL(I)
 102   CONTINUE
 C
       CALL CLRSCN
       WRITE(*,20)
 20    FORMAT(//'  ENTER # OF RIVER TEMPERATURES (<7) : '\)
       READ(*,*)ITEM
       WRITE(*,21)
 21    FORMAT(/'  ENTER THESE TEMPERATURES')
       DO 103 I=1,ITEM
       WRITE(*,22)I
 22    FORMAT(10X,' TEMP. ',I2,':  '\)
       READ(*,*)TMP(I)
 103   CONTINUE
 C
       CALL CLRSCN
       WRITE(*,23)
 23    FORMAT(//'  ARE YOU CONSIDERING AMMONIA? 1=YES  0=NO : '\)
       READ(*,*)IAM
       IF(IAM.EQ.1)THEN
         WRITE(*,24)
 24      FORMAT(/'  ENTER # OF PH VALUES (<5) : '\)
         READ(*,*)IPH
         WRITE(*,25)
 25      FORMAT(/'  ENTER THESE PH VALUES')
         DO 104 I=1,IPH
         WRITE(*,26)I
 26      FORMAT(10X,' PH ',I2,':  '\)
         READ(*,*)PH(I)
 104     CONTINUE
       ENDIF
 C
       WRITE(*,27)
 27    FORMAT(//'  ENTER EFFLUENT CONCENTRATION : '\)
       READ(*,*)CEFL
       WRITE(*,28)
 28    FORMAT(//'  ENTER BACKGROUND CONCENTRATION : '\)
       READ(*,*)CBKG
```

```
      WRITE(*,29)
29    FORMAT(//'  ENTER PROVINCIAL WATER QUALITY OBJECTIVE : '\)
      READ(*,*)CS
      WRITE(*,30)
30    FORMAT(//'  ENTER TEMPERATURE COEFFICIENT : '\)
      READ(*,*)THETA
      WRITE(*,31)
31    FORMAT(//'  ENTER DECAY RATE OF BACKGROUND : '\)
      READ(*,*)RBK
      WRITE(*,32)
32    FORMAT(//'  ENTER THE TEMPERATURE THIS RATE IS KNOWN AT : '\)
      READ(*,*)TEMP
      WRITE(*,33)
33    FORMAT(//'  ENTER THE DOWNSTREAM BOUNDARY DISTANCE : '\)
      READ(*,*)XWCP
      CALL CLRSCN
      WRITE(*,34)
34    FORMAT(//'  ENTER VALUES OF BETA '/)
      DO 105 I=1,NTR
      WRITE(*,35)I
35    FORMAT(10X,'  TRANSECT ',I2,':  '\)
      READ(*,*)BETA(I)
105   CONTINUE
      WRITE(*,36)
36    FORMAT(//'  ENTER DECAY RATES AT EACH TRANSECT '/)
      DO 106 I=1,NTR
      WRITE(*,37)I
37    FORMAT(10X,'  TRANSECT ',I2,':  '\)
      READ(*,*)RKS(I)
106   CONTINUE
C
C     NOW WRITE ALL THIS DATA TO THE INPUT FILE FOR MIXAPPLN.FOR
C     MAIN PROGRAM.
C
      OPEN(5,FILE='APINCAL.DAT',STATUS='NEW')
      WRITE(5,1)CONNAME
      WRITE(5,1)POLLU
      WRITE(5,*)QRS,BPWR,HPWR,UPWR,TEMP,NTR
      DO 50 I=1,NTR
      WRITE(5,*)X(I),BS(I),HS(I),US(I)
50    CONTINUE
      WRITE(5,*)(BETA(I),I=1,NTR)
      WRITE(5,*)IFR,(QRUP(I),I=1,IFR)
      WRITE(5,*)ITEM,(TMP(I),I=1,ITEM)
      WRITE(5,*)IEFL,(QEFL(I),I=1,IEFL)
      WRITE(5,*)IAM
      IF(IAM.EQ.1)WRITE(5,*)IPH,(PH(I),I=1,IPH)
      WRITE(5,*)QCP,CEFL,CBKG,CS,THETA,RBK,XWCP
      WRITE(5,*)(RKS(I),I=1,NTR)
      WRITE(5,55)
55    FORMAT(' 3')
      WRITE(5,5558)CHAR(26)
5558  FORMAT(A)
      CLOSE(5)
      IRUN=IFR*ITEM*IEFL*IPH
      RETURN
      END
```

```
C
C
      SUBROUTINE CLRSCN
      WRITE(*,101)CHAR(27),'[2J'
101   FORMAT(1X,A,A\)
      RETURN
      END
```

```
$DEBUG
C*********************************************************************
C                                                                    *
C     PROGRAM PLTCRIT.FOR USES DATA GENERATED BY THE MIXING ZONE     *
C     APPLICATION PROGRAM " MIXAPPLN.FOR " AND PLOTS CRITICAL        *
C     POINTS FOR VARIOUS MANAGEMENT OPTIONS.                         *
C     WRITTEN BY R. JARVIS                                           *
C     GORE & STORRIE 1986                                            *
C                                                                    *
C*********************************************************************
      COMMON/A/ X(10),XL(4,20),CL(4,20),XLS(4),XS(10)
      COMMON/B/ QRUP(10),QEFL(10),PH(10),RKS(10),TMP(10),ZML(10)
      CHARACTER*80 TITLE
      CHARACTER*20 POLLU
C
      IAM=0
      MPH=1
C
C     OPEN THE FILE "PLAPPLN" PRODUCED BY "MIXAPPLN.FOR"
C
      OPEN(5,FILE='PLAPPLN',STATUS='OLD')
      READ(5,*)JRUN
      READ(5,2)TITLE
      READ(5,2)POLLU
2     FORMAT(A)
      IF(POLLU.EQ.'AMMONIA      ')IAM=1
      READ(5,*)NTR
      DO 101 I=1,NTR
      READ(5,*)X(I)
101   CONTINUE
      READ(5,*)MQ,(QRUP(I),I=1,MQ)
      READ(5,*)MT,(TMP(I),I=1,MT)
      READ(5,*)MF,(QEFL(I),I=1,MF)
      IF(IAM.EQ.1)READ(5,*)MPH,(PH(I),I=1,MPH)
      READ(5,*)QCP,CEFL,CBKG,CS,THETA,RBK,XWCP
      READ(5,*)(RKS(I),I=1,NTR)
      DO 1002 I=1,JRUN
      READ(5,*)ZML(I)
      DO 102 J=1,4
      READ(5,*)XL(J,I),CL(J,I)
102   CONTINUE
1002  CONTINUE
      CLOSE(5)
C
      WRITE(*,103)
103   FORMAT('     PLOT LOCATION 1=SCREEN 2=PLOTTER 3=PRINTER : '\)
      READ(*,*)IPL
      IF(IPL.EQ.1)CALL PLOTS(0,0,99)
      IF(IPL.EQ.2)CALL PLOTS(0,9600,80)
      IF(IPL.EQ.3)CALL PLOTS(0,0,11)
C
      MM=0
      MRUN=0
      DO 20 JF=1,MF
      DO 20 JQ=1,MQ
      DO 20 JT=1,MT
      DO 20 JPH=1,MPH
```

```
      CALL SIMPLX
      IF(IPL.EQ.1)CALL FACTOR(.75)
      IF(IPL.EQ.2)CALL FACTOR(.9)
      MRUN=MRUN+1
      MM=MM+1
      IF(MM.EQ.2)MM=0
      IF(MM.EQ.1)CALL PLOT(.5,4.0,-3)
      IF(MM.EQ.0)CALL PLOT(.0,-3.5,-3)
      CALL PLOT(0.,0.,3)
      CALL PLOT(0.,2.,2)
      DO 104 J=1,11
      SJ=FLOAT(J-1)*.2
      DJ=-.15
      IF(J.EQ.2)CALL COLOR(1,IERR)
      IF(J.EQ.11)CALL COLOR(0,IERR)
      CALL PLOT(DJ,SJ,3)
      CALL PLOT(10.,SJ,2)
104   CONTINUE
      DO 1004 J=1,11
      SN=FLOAT(J-1)/FLOAT(10)
      SJ=FLOAT(J-1)*.2
      SSJ=SJ-.1
      CALL NUMBER(-.2,SSJ,.06,SN,0.,1)
1004  CONTINUE
      CALL SYMBOL(-.25,.15,.1,'FLOW FRACTION QY/QT',90.,19)
      IF(X(NTR).GT.XL(4,MRUN))SCALE=8.0/X(NTR)
      IF(X(NTR).LE.XL(4,MRUN))SCALE=8.0/XL(4,MRUN)
      XLS(1)=XL(1,MRUN)*SCALE
      XLS(2)=XL(2,MRUN)*SCALE
      XLS(3)=XL(3,MRUN)*SCALE
      XLS(4)=XL(4,MRUN)*SCALE
44    CONTINUE
      DO 105 J=1,NTR
      XS(J)=X(J)*SCALE
      XSX=XS(J)
      CALL PLOT(XSX,0.,3)
      CALL PLOT(XSX,2.05,2)
      STR=FLOAT(J)
      CALL NUMBER(XSX-.05,2.12,.075,STR,0.,-1)
105   CONTINUE
      DO 106 J=1,4
      YS=FLOAT(J)*.2
      XP=XLS(J)
      CALL COLOR(3,IERR)
      CALL PLOT(XP,0.,3)
      CALL PLOT(XP,YS,2)
      CALL SYMBOL(XP,YS,.1,1,0.,-1)
      CC=CL(J,MRUN)
      XX=XL(J,MRUN)
      CALL COLOR(0,IERR)
      CALL SYMBOL(XP-.25,YS+.06,.07,'CONC=',0.,5)
      CALL NUMBER(XP+.10,YS+.06,.07,CC,0.,2)
      CALL SYMBOL(XP-.25,YS+.21,.07,'DIST=',0.,5)
      CALL NUMBER(XP+.10,YS+.21,.07,XX,0.,2)
106   CONTINUE
      IF(XL(4,MRUN).GT.X(NTR))SS=10.*XL(4,MRUN)/8.0
      IF(XL(4,MRUN).LE.X(NTR))SS=10.0*X(NTR)/8.0
```

```
      SS=SS/10.
      CALL STAXIS(.07,.07,.04,.05,2)
      CALL AXIS(0.,0.,'DISTANCE DOWNSTREAM FROM OUTFALL',-32,10.,0.,0.,S
     *S)
      CALL PLOT(10.,0.,3)
      CALL PLOT(10.,2.,2)
      CALL SYMBOL(3.,2.2,.07,'TRANSECT NUMBER',0.,15)
      IF(MM.EQ.1)THEN
      CALL SYMBOL(1.,3.6,.15,TITLE,0.,80)
      CALL SYMBOL(1.,3.4,.1,'PLOT OF CRITICAL POINTS FROM PROGRAM MIXAPP
     *LN',0.,45)
      CALL SYMBOL(1.,3.2,.1,'POLLUTANT : ',0.,12)
      CALL SYMBOL(2.5,3.2,.1,POLLU,0.,20)
      ELSE
      ENDIF
      CALL SYMBOL(0.,2.8,.1,'RUN NUMBER ',0.,11)
      RUN=FLOAT(MRUN)
      CALL NUMBER(1.2,2.8,.1,RUN,0.,0)
      CALL SYMBOL(3.,2.8,.075,'RIVER FLOW RATE =',0.,17)
      QQ=QRUP(JQ)
      CALL NUMBER(5.0,2.8,.075,QQ,0.,3)
      CALL SYMBOL(6.,2.8,.075,'EFFLUENT CONCENTRATION =',0.,24)
      CALL NUMBER(8.0,2.8,.075,CEFL,0.,2)
      CALL SYMBOL(6.,2.6,.075,'MIXING ZONE LENGTH =',0.,22)
      ZMM=ZML(MRUN)
      CALL NUMBER(8.0,2.6,.075,ZMM,0.,1)
      CALL SYMBOL(3.0,2.7,.075,'EFFLUENT FLOW RATE =',0.,22)
      QQ=QEFL(JF)
      CALL NUMBER(5.0,2.7,.075,QQ,0.,3)
      CALL SYMBOL(6.0,2.7,.075,'RIVER TEMPERATURE =',0.,21)
      TTMP=TMP(JT)
      CALL NUMBER(8.0,2.7,.075,TTMP,0.,1)
      CALL SYMBOL(3.0,2.6,.075,'RIVER ACIDITY
 PH =',0.,21)
      PPH=PH(JPH)
      CALL NUMBER(5.,2.6,.075,PPH,0.,1)
      IF(MM.EQ.0)CALL PLOT(0.,0.,-999)
20    CONTINUE
999   CALL PLOT(0.,0.,999)
      STOP
      END
```

```
$DEBUG
C*********************************************************************
C     PROGRAM NAME MIXPRED.FOR DEVELOPED FROM MIXCALBN TO PREDICT     *
C     MIXING ZONES IN A RIVER WITH A PIPE OUTFALL                     *
C*********************************************************************
C     PROGRAM NAME: MIXPRED   * * STREAMTUBE MODEL FOR PIPE OUTFALL   *
C     DEVELOPED BY T. P. H. GOWDA, WATER RESOURCES BRANCH, MOE.       *
C     THIS PROGRAM PREDICTS LAT'L & LONG'L DISTRN. OF CONSERVATIVE    *
C     AND NONCONSERVATIVE MATERIALS DISCHARGED INTO A RIVER FROM      *
C     A PIPE OUTFALL LOCATED AT BANK OR IN RIVER(VERT. LINE SOURCE).  *
C     PROGRAM MODIFIED: JUNE 1983  FOR DILUTION FACTOR AND TO         *
C     TO TERMINATE CALC'NS IF CONCN < 1.0E-04.                        *
C                                                                     *
C     GORE &  STORRIE  1986                                           *
C                                                                     *
C*********************************************************************
      DIMENSION C(50,102),CUI(50,102)
      REAL*8 X(50),XX(50),P1,P2,P3,P4,T1,T2,T3,T4,RKS(50),QY(502),
     *THETA,BPWR,HPWR,UPWR,QRTO,QT,RBT,QRS,QRUP,QEFL,RBK,CTDP,PHDR,
     *RF(50),BS(50),HS(50),US(50),BETA(50),BW,HW,UW,RKT,R,PHI,TMP,
     *B(50),H(50),U(50),BSUM(50),TOT(50),VOL(50),TEMPS,PAX1,PAX2,
     *A3,QCP,DELQ
      CHARACTER*80 TITLE
      CHARACTER*20 FILIN,FILOUT
C
C     INPUT DATA
C     MIXPRED  READS FILE "PINCAL.DAT" FROM SUBROUTINE SETUP
C     THE FIRST TIME THROUGH AND MAKES FILE "PPINCAL.DAT" TO
C     BE USED ON SUBSEQUENT RUNS.
C
      CALL SETUP
      OPEN(5,FILE='PPINPRE.DAT',STATUS='OLD')
      OPEN(4,FILE='PREDOUT.DAT',STATUS='NEW')
      OPEN(6,FILE='PLTPRED',STATUS='NEW')
C
C     ICAL IS THE FLAG IN PLCALPC THAT INDICATES A PIPE OUTFALL
C     TO THE PLOTTING PROGRAM CONMIX.FOR
C
      ICAL=1
      WRITE(6,*)ICAL
      WRITE(4,2)
2     FORMAT(/'  ENTER TITLE OF STUDY')
      READ(5,3) TITLE
      WRITE(6,3)TITLE
3     FORMAT(A)
      WRITE(4,3)TITLE
35    WRITE(4,4)
4     FORMAT('   ENTER QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK')
      READ(5,*) QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK
      WRITE(4,400) QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK
400   FORMAT(F7.2,2X,F5.2,2X,F5.2,2X,F4.2,2X,F6.3,2X,F6.2,2X,F4.2)
43    WRITE(4,19)
19    FORMAT('   ENTER DESIGN CASE: QRUP,QEFL,CEFL,CBKG,TMP')
      READ(5,*)QRUP,QEFL,CEFL,CBKG,TMP
      WRITE(4,401)QRUP,QEFL,CEFL,CBKG,TMP
401   FORMAT(2X,F7.2,2X,F8.3,2X,F8.2,2X,F5.2,2X,F6.2)
33    WRITE(4,5)
```

```
5     FORMAT('   ENTER NTR,NYZ,QCP')
      READ(5,*) NTR,NYZ,QCP
      WRITE(6,*)NTR
      WRITE(6,*)NYZ
      WRITE(4,402)NTR,NYZ,QCP
402   FORMAT(2X,I3,3X,I3,F5.1)
      WRITE(4,6)NTR
6     FORMAT('   ENTER ',I2,' VALUES OF X,BS,HS,US')
      READ(5,*) (X(I),BS(I),HS(I),US(I),I=1,NTR)
      DO 405 I=1,NTR
      WRITE(4,403)I,X(I),BS(I),HS(I),US(I)
      WRITE(6,8234)I,X(I)
8234  FORMAT(2X,I3,2X,F8.2)
403   FORMAT(2X,I3,2X,F8.2,3X,F8.2,3X,F6.2,3X,F7.4)
405   CONTINUE
47    WRITE(4,55)NTR
      WRITE(*,55)NTR
55    FORMAT(/'   ENTER ',I2,' VALUES OF DECAY'/)
      DO 9911 I=1,NTR
      WRITE(*,5656)I
5656  FORMAT('   TRANSECT ',I2,' : '\)
      READ(*,*) RKS(I)
9911  CONTINUE
      DO 408 I=1,NTR
      WRITE(4,406)I,RKS(I)
      WRITE(6,406)I,RKS(I)
406   FORMAT(2X,I3,F9.7)
408   CONTINUE
45    CONTINUE
      WRITE(*,7777)
      WRITE(4,7777)
7777  FORMAT(/'   ENTER VALUES OF BETA'/)
      DO 409 I=1,NTR
      WRITE(*,7778)I
      WRITE(4,7778)I
7778  FORMAT('   TRANSECT ',I3,' : '\)
      READ(*,*)BETA(I)
      WRITE(4,411)BETA(I)
411   FORMAT(5X,F9.7)
      WRITE(6,410)I,BETA(I)
410   FORMAT(2X,I3,F9.7)
409   CONTINUE
      WRITE(4,52)
52    FORMAT('   ARE YOU CONSIDERING UN-IONIZED AMMONIA: YES=1   NO=0')
      READ(5,*) AMONIA,PH
      IF(AMONIA.EQ.0)GO TO 101
      WRITE(4,102)
102   FORMAT('   ENTER THE PH OF UN-IONIZED AMMONIA')
      WRITE(4,412)PH
412   FORMAT('  THE PH OF UN-IONIZED AMMONIA IS   ',F3.1)
101   CONTINUE
C
C  CALCULATE FLOW & TEMP'R PARAMETERS
C
      DELTA=0.0001
      QT=QRUP+QEFL
      QRTO=QT/QRS
```

```
      CTDP=THETA**(TMP-TEMPS)
      RBT=RBK*CTDP
      DELQ=QT/NYZ
      NQ=NYZ+1
      CA=(CEFL*QEFL /QT)
      KCP=QCP/DELQ+1.5
      IF(KCP.LE.1)KCP=KCP+3
      DO 12 I=1,NTR
      BSUM(I)=0.
   12 TOT(I)=0.
      DO 14 I=1,NTR
C
C   CALCULATE B,H,U FOR FLOW=QT, FROM LEOPOLD-MADDOCK EQNS.
C
      B(I)=BS(I)*QRTO**BPWR
      H(I)=HS(I)*QRTO**HPWR
      U(I)=US(I)*QRTO**UPWR
C
C   CALCULATE WEIGHTED MEAN VALUES BW,HW,UW FROM OUTFALL TO TRANSECT(I)
C
      IF(I.GE.2) GO TO 60
      XX(1)=X(1)
      BW=B(1)
      HW=H(1)
      UW=U(1)
      BSUM(1)=B(1)*XX(1)
      VOL(1)=B(1)*H(1)*XX(1)
      TOT(1)=XX(1)/U(1)
      GO TO 62
   60 I1=I-1
      XX(I)=X(I)-X(I1)
      BSUM(I)=BSUM(I1)+0.5*XX(I)*(B(I1)+B(I))
      VOL(I)=VOL(I1)+0.25*XX(I)*(B(I1)+B(I))*(H(I1)+H(I))
      TOT(I)=TOT(I1)+XX(I)/U(I)
      BW=BSUM(I)/X(I)
      HW=VOL(I)/(X(I)*BW)
      UW=QT/(BW*HW)
C
C   CALCULATE PRODUCT FUNCTION FOR DECAY, RF(I).
C
   62 RKT=CTDP*RKS(I)
      CBKX=CBKG*DEXP(-RBT*TOT(I))
      A3=(RKT*XX(I))/U(I)
      R=DEXP(-A3)
      IF(I.GE.2) GO TO 64
      RF(1)=R
      GO TO 66
   64 RF(I)=RF(I1)*R
   66 CONTINUE
      PHI=BETA(I)*X(I)/BW
      PHDR=4.0*PHI
      CRPX=0.5*CA*RF(I)/DSQRT(3.1416*PHI)
      BGX=PHI*ALOG(1./DELTA)
      SBG=SQRT(BGX)
      WRITE(4,40) I,BETA(I),RKS(I)
40    FORMAT(/5X,'TRANSECT: ',I2,2X,'BETA=',F9.6,2X,'RKS=',F9.6,2X,
     */7X,'X',9X,'BW',9X,'HW',8X,'UW')
```

```
      WRITE(4,23) X(I),BW,HW,UW
23    FORMAT(2X,4(F9.3,1X))
      WRITE(4,42)
42    FORMAT(4X,'QY',5X,'C(X,QY)',5X,'CUI',9X,'C/CA',7X,'QY/QT',6X,
     *'DIL FAC'/)
      DO 16 K=1,NQ
      QY(K)=FLOAT(K-1)*DELQ
      IF (QY(K).GT.QT) QY(K)=QT
      PAX1=(QY(K)-QCP)/QT
      PAX2=(QY(K)+QCP)/QT
C
C  DETERMINE NO. OF IMAGES REQUIRED
C
      AN1=(0.5*PAX1-SBG)-0.5
      AN2=(0.5*PAX1+SBG)+0.5
      AN3=-AN2
      AN4=-AN1
      NM1=IFIX(AN1)
      NM2=IFIX(AN2)
      NM3=IFIX(AN3)
      NM4=IFIX(AN4)
      NN1=1+NM2+IABS(NM1)
      NN2=1+IABS(NM3)+IABS(NM4)
      IF(NN1.GE.NN2)NN=NN1+1
      IF(NN1.LT.NN2)NN=NN2+1
C
C  COMPUTATION OF CONC'N DISTR'NS.
C
      SUM=0.
      DO 32 J=1,NN
      N=J-1
      P1=(PAX1-2.*N)**2/PHDR
      P2=(PAX2+2.*N)**2/PHDR
      CALL PDET(P1,T1)
      CALL PDET(P2,T2)
      IF(N.LE.0) GO TO 30
      P3=(PAX1+2.*N)**2/PHDR
      P4=(PAX2-2.*N)**2/PHDR
      CALL PDET(P3,T3)
      CALL PDET(P4,T4)
      GO TO 32
   30 T3=0.
      T4=0.
   32 SUM=SUM+T1+T2+T3+T4
      C(I,K)=CRPX*SUM+CBKX
C
C  CALCULATE UN-IONIZED AMMONIA CONCENTRATIONS*  OPTIONAL *
C
      IF(AMONIA.LE.0) GO TO 15
      PKA=0.09018+2729.92/(TMP+273.2)
      PF=PKA-PH
      PCTU=1./(1.+10.**PF)
      CUI(I,K)=C(I,K)*PCTU
   15 CONTINUE
   16 CONTINUE
      NQQ=NQ
   18 CONTINUE
```

```
C
C  PRINT OUTPUT
C
      DO 20 K=1,NQ
      RC=C(I,K)/CA
      RQ=QY(K)/QT
      CNET=C(I,K)-CBKX
      IF(CNET.LE.0.000009) CNET=-CEFL
      DLF=CEFL/CNET
      IF(AMONIA.LE.0) CUI(I,K)=0.0
      WRITE(6,25)K,QY(K),C(I,K),CUI(I,K),RC,RQ,DLF
20    WRITE(4,25)K,QY(K),C(I,K),CUI(I,K),RC,RQ,DLF
25    FORMAT(I2,2X,F10.2,2X,4(F9.4,2X),F10.2)
14    CONTINUE
999   CONTINUE
      WRITE(4,585)CHAR(26)
585   FORMAT(A)
      WRITE(6,585)CHAR(26)
      CLOSE(4)
      CLOSE(5)
      CLOSE(6)
      WRITE(*,1234)
1234  FORMAT(//'    THE OUTPUT FILE FROM MIXPRED.FOR IS CALLED'//'
     *          " PREDOUT.DAT "')

      STOP
      END
C
      SUBROUTINE PDET(P,T)
      REAL*8 P,T
      IF(P.GE.40.0)GO TO 10
      T=DEXP(-P)
      GO TO 12
   10 T=0.0
   12 CONTINUE
      RETURN
      END
C
C
      SUBROUTINE SETUP
      DIMENSION RKS(20),BS(20),ZAV(20),VAV(20),X(20),DY(15)
      CHARACTER*80 TITLE
      OPEN(7,FILE='PINCAL.DAT',STATUS='OLD')
      READ(7,1)TITLE
1     FORMAT(A)
      READ(7,*)QRS,BP,HP,UP,THETA
      READ(7,*)QRUP,QEFL,CEFL,CBKG,TMP
      READ(7,*)NTR,NYZ,QCP
      DO 2 I=1,NTR
      READ(7,*)X(I),BS(I),ZAV(I),VAV(I)
2     CONTINUE
      CALL CLRSCN
      WRITE(*,3)BP,HP,UP
3     FORMAT(/////'   THE EXPONENTS FOR THE LEOPOLD-MADDOCK EQNS ARE'/
     *'  WIDTH EXP: ',F5.3/'  DEPTH EXP: ',F5.3/'  VEL.  EXP: ',F5.3)
      WRITE(*,4)
4     FORMAT(///'   DO YOU WISH TO CHANGE THEM?   YES=1  NO=0  : '\)
```

```
      READ(*,*)ICH
11    IF(ICH.EQ.1)THEN
        WRITE(*,5)
5       FORMAT(/'  WIDTH EXP=  '\)
        READ(*,*)BP
        WRITE(*,6)
6       FORMAT(/'  DEPTH EXP=  '\)
        READ(*,*)HP
        WRITE(*,7)
7       FORMAT(/'  VEL. EXP=   '\)
        READ(*,*)UP
      ELSE
        CONTINUE
      ENDIF
      TOT=BP+HP+UP
      CALL CLRSCN
      IF(TOT.NE.1.)THEN
         WRITE(*,10)
10       FORMAT(/////'     THE EXPONENTS MUST SUM TO 1.0'/'  RE-ENTER TH
     *EM')
         GO TO 11
      ELSE
         CONTINUE
      ENDIF
      CALL CLRSCN
      WRITE(*,8)QRUP,QEFL
8     FORMAT(/////'    RIVER FLOW RATE ABOVE OUTFALL=',F10.2/'    OUTFAL
     *L FLOW RATE=      ',F10.2//'   DO YOU WISH TO CHANGE EITHER?  YES=
     *1  NO=0  '\)
      READ(*,*)IC
      IF(IC.EQ.1)THEN
        WRITE(*,9)
9       FORMAT('   RIVER FLOW RATE=  '\)
        READ(*,*)QRUP
        WRITE(*,12)
12      FORMAT('   OUTFALL FLOW RATE=  '\)
        READ(*,*)QEFL
        QRS=QRUP+QEFL
      ENDIF
      CALL CLRSCN
C
      WRITE(*,28)CEFL
28    FORMAT(/////'    THE EFFLUENT CONCENTRATION IS :',F10.2,//'
     *DO WISH TO CHANGE IT?  YES=1  NO=0  '\)
      READ(*,*)IC
      IF(IC.EQ.1)THEN
        WRITE(*,30)
30      FORMAT(/'   THE NEW EFFLUENT CONC. =  '\)
        READ(*,*)CEFL
      ENDIF
      CALL CLRSCN
      WRITE(*,31)CBKG
31    FORMAT(/////'     THE BACKGROUND CONCENTRATION IS :',F10.2,//'
     *DO YOU WISH TO CHANGE IT?  YES=1  NO =0  '\)
      READ(*,*)IC
      IF(IC.EQ.1)THEN
        WRITE(*,32)
```

```
32      FORMAT(/'   ENTER NEW BACKGROUND CONC.:  '\)
        READ(*,*)CBKG
      ENDIF
      CALL CLRSCN
C
      WRITE(*,20)
20    FORMAT(/////'    ENTER A DECAY RATE FOR THE RIVER BACKGROUND: '\)
      READ(*,*)RBK
      WRITE(*,21)
21    FORMAT(/'    AT WHAT TEMPERATURE IS THIS RATE KNOWN? IN C : '\)
      READ(*,*)TEMP
      WRITE(*,22)
22    FORMAT(/'    WHAT IS THE RIVER TEMPERATURE? IN C :  '\)
      READ(*,*)TMP
      CALL CLRSCN
      WRITE(*,23)
23    FORMAT(/////'     THE OUTFALL IS AT SHORE '//'    DO YOU WISH TO C
     *HANGE IT?  YES=1   NO=0  '\)
      READ(*,*)IC
      IF(IC.EQ.1)THEN
        WRITE(*,24)
24      FORMAT(/'   ENTER THE DISTANCE OF THE OUTFALL FROM THE BANK : '\
     *)
        READ(*,*)YOUT
        OPEN(9,FILE='SCALE.DAT',STATUS='OLD')
        READ(9,*)(DY(I),I=1,11)
        CLOSE(9)
        IG=0
9079    IG=IG+1
        IF(YOUT.LE.DY(IG))THEN
        A=DY(IG)-YOUT
        DELY=DY(IG)-DY(IG-1)
        A1=FLOAT(IG-1)/10.
        QCP=(A1-.1*(A/DELY))*QRS
        ELSE
          GO TO 9079
        ENDIF
      ENDIF
C
      CALL CLRSCN
      WRITE(*,50)
50    FORMAT(/////'    DO YOU WISH TO CONSIDER AMMONIA?  YES=1  NO=0  '\
     *)
      READ(*,*)IAM
      IF(IAM.EQ.1)THEN
        WRITE(*,51)
51      FORMAT(/'   ENTER PH  '\)
        READ(*,*)PH
      ELSE
        PH=7.0
      ENDIF
      CALL CLRSCN
C
      OPEN(7,FILE='PPINPRE.DAT',STATUS='NEW')
      WRITE(7,1)TITLE
      WRITE(7,111)QRS,BP,HP,UP,THETA,TEMP,RBK
111   FORMAT(2X,F9.2,4(2X,F5.3),2X,F6.2,2X,F10.7)
```

```
      WRITE(7,112)QRUP,QEFL,CEFL,CBKG,TMP
112   FORMAT(2X,F9.2,2X,F8.2,2X,F8.3,2X,F6.3,2X,F6.2)
      WRITE(7,*)NTR,NYZ,QCP,YOUT
      DO 40 I=1,NTR
      WRITE(7,*)X(I),BS(I),ZAV(I),VAV(I)
40    CONTINUE
      WRITE(7,*)IAM,PH
      WRITE(7,585)CHAR(26)
585   FORMAT(A)
      CLOSE(7)
      RETURN
      END
C
C
        SUBROUTINE CLRSCN
        WRITE(*,100)CHAR(27),'[2J'
100     FORMAT(1X,A,A\)
        RETURN
        END
```

```
$DEBUG
C*********************************************************************
C                                                                    *
C     PROGRAM MIXCADIF.FOR IS THE MICRO-EDITION OF MIXCADIF BY H. GOWDA *
C                                                                    *
C     PROGRAM NAME: MIXCADIF  * *                                    *
C     DEVELOPED BY T. P. H. GOWDA, WATER RESOURCES BRANCH, MOE.      *
C     THIS PROGRAM PREDICTS LAT'L & LONG'L DISTRN. OF CONSERVATIVE   *
C     OR NONCONSERVATIVE MATERIAL DISCHARGED INTO A RIVER FROM       *
C     A DIFFUSER OUTFALL                                             *
C                                                                    *
C     GORE & STORRIE  1986                                           *
C                                                                    *
C*********************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/C/ C(25,101),CUI(25,101)
      COMMON/VAR/ X(25),XX(25),RKS(25),QY(101),RF(25),BS(25),HS(25)
     *,US(25),BETA(25),B(25),H(25),U(25),BSUM(25),TOT(25),VOL(25)
      CHARACTER*80 TITLE
C
C  INPUT DATA
C
      CALL CLRSCN
      CALL SETUP
      OPEN(6,FILE='CADOUT.DAT',STATUS='NEW')
      OPEN(5,FILE='PPINCAD.DAT',STATUS='OLD')
      OPEN(7,FILE='PLTPRED',STATUS='NEW')
      WRITE(6,2)
2     FORMAT(/'    ENTER TITLE OF STUDY')
      READ(5,3) TITLE
      WRITE(6,3)TITLE
      ICAL=2
      WRITE(7,*)ICAL
      WRITE(7,3)TITLE
3     FORMAT(A)
35    WRITE(6,4)
4     FORMAT('    ENTER QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK')
      READ(5,*) QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK
      WRITE(6,3000)QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK
3000  FORMAT(2X,F10.3,2X,F6.3,2X,F6.3,2X,F5.3,2X,F7.4,2X,F7.4,2X,F5.2)
43    WRITE(6,19)
19    FORMAT('    ENTER DESIGN CASE: QRUP,QEFL,CEFL,CBKG,TMP')
      READ(5,*)QRUP,QEFL,CEFL,CBKG,TMP
      WRITE(6,3001)QRUP,QEFL,CEFL,CBKG,TMP
3001  FORMAT(2X,F10.3,2X,F6.2,2X,F8.2,2X,F5.2,2X,F6.2)
33    WRITE(6,5)
5     FORMAT('   ENTER NTR,NYZ,NOUT,QCP1,QCP2')
      READ(5,*) NTR,NYZ,NOUT,QCP1,QCP2
      WRITE(7,*)NTR
      WRITE(7,*)NYZ
      WRITE(6,3003)NTR,NYZ,NOUT,QCP1,QCP2
3003  FORMAT(2X,I3,2X,I3,2X,I3,2X,F7.2,2X,F7.2)
      WRITE(6,6)
6     FORMAT('   ENTER NTR VALUES OF X,BS,HS,US')
      READ(5,*) (X(I),BS(I),HS(I),US(I),I=1,NTR)
      DO 3004 I=1,NTR
      WRITE(7,2345)I,X(I)
```

```
2345  FORMAT(2X,I2,5X,F8.2)
      WRITE(6,3005)X(I),BS(I),HS(I),US(I)
3005  FORMAT(2X,F8.2,2X,F8.2,2X,F5.2,2X,F6.3)
3004  CONTINUE
47    WRITE(*,55)NTR
55    FORMAT(//'    ENTER ',I2,' VALUES OF DECAY COEFFICIENT'/)
      DO 3077 I=1,NTR
      WRITE(*,7717)I
7717  FORMAT('     TRANSECT ',I2,' : '\)
      READ(*,*)RKS(I)
3077  CONTINUE
      CALL CLRSCN
      DO 3006 I=1,NTR
      WRITE(6,3007)RKS(I)
      WRITE(7,*)I,RKS(I)
3007  FORMAT(3X,F10.8)
3006  CONTINUE
45    CONTINUE
      CALL CLRSCN
      WRITE(*,8)NTR
8     FORMAT(//'   ENTER ',I2,' VALUES OF BETA'/)
      DO 409 I=1,NTR
      WRITE(*,7778)I
7778  FORMAT('     TRANSECT ',I2,' : '\)
      READ(*,*)BETA(I)
      WRITE(6,410)I,BETA(I)
      WRITE(7,410)I,BETA(I)
410   FORMAT(2X,I3,2X,F9.7)
409   CONTINUE
      WRITE(6,52)
52    FORMAT('   UN-IONIZED AMMONIA:  ENTER 1 FOR YES,  0 FOR NO
 AND EN
     *TER PH VALUE ON THE SAME LINE')
      READ(5,*) AMONIA,PH
      WRITE(6,3010)AMONIA,PH
3010  FORMAT(2X,F3.2,3X,F5.2)
C  CALCULATE FLOW & TEMP'R PARAMETERS
      DELTA=0.0001
      QT=QRUP+QEFL
      QRTO=QT/QRS
      CTDP=THETA**(TMP-TEMPS)
      RBT=RBK*CTDP
      DELQ=QT/NYZ
      NQ=NYZ+1
      KCP=QCP2/DELQ+1.5
      WRITE(6,24)TITLE
24    FORMAT(//2X,A)
      WRITE(6,56) QRUP,CBKG,TMP,QEFL,CEFL,QCP1,QCP2
56    FORMAT(2X,'UPSTREAM FLOW=',F8.3,'   BACKGROUND CONC.=',F8.3,'  DES
     *IGN TEMP=',F5.1/2X,'EFFLUENT FLOW=',F8.3,'   EFFLUENT CONC.=',F8.2
     */2X,'DIFFUSER OUTFALL LOCATED BETWEEN',F7.2,'  AND  ',F7.2/)
      CA=CEFL*QEFL/QT
      DO 12 I=1,NTR
      BSUM(I)=0.
12    TOT(I)=0.
      DO 14 I=1,NTR
C
```

```
C   CALCULATE B,H,U FOR FLOW=QT, FROM LEOPOLD-MADDOCK EQNS.
C
      B(I)=BS(I)*QRTO**BPWR
      H(I)=HS(I)*QRTO**HPWR
      U(I)=US(I)*QRTO**UPWR
C
C   CALCULATE WEIGHTED MEAN VALUES BW,HW,UW FROM OUTFALL TO TRANSECT(I)
C
      IF(I.GE.2) GO TO 60
      XX(1)=X(1)
      BW=B(1)
      HW=H(1)
      UW=U(1)
      BSUM(1)=B(1)*XX(1)
      VOL(1)=B(1)*H(1)*XX(1)
      TOT(1)=XX(1)/U(1)
      GO TO 62
60    I1=I-1
      XX(I)=X(I)-X(I1)
      BSUM(I)=BSUM(I1)+0.5*XX(I)*(B(I1)+B(I))
      VOL(I)=VOL(I1)+0.25*XX(I)*(B(I1)+B(I))*(H(I1)+H(I))
      TOT(I)=TOT(I1)+XX(I)/U(I)
      BW=BSUM(I)/X(I)
      HW=VOL(I)/(X(I)*BW)
      UW=QT/(BW*HW)
C
C   CALCULATE PRODUCT FUNCTION FOR DECAY, RF(I).
C
62    RKT=CTDP*RKS(I)
      CBKX=CBKG*DEXP(-RBT*TOT(I))
      A3=(RKT*XX(I))/U(I)
      R=DEXP(-A3)
      IF(I.GE.2) GO TO 64
      RF(1)=R
      GO TO 66
64    RF(I)=RF(I1)*R
66    CONTINUE
      PHI=BETA(I)*X(I)/BW
      PHD2=2.0*DSQRT(PHI)
      CRPX=0.5*CA*RF(I)*QT/(QCP2-QCP1)
      WRITE(6,40) I,BETA(I),RKS(I)
40    FORMAT(/5X,'TRANSECT: ',I2,2X,'BETA=',F9.6,2X,'RKS=',F9.6,/7X,'X',
     *9X,'BW',9X,'HW',8X,'UW')
      WRITE(6,23) X(I),BW,HW,UW
23    FORMAT(2X,4(F9.3,1X)/)
      WRITE(6,42)
42    FORMAT(4X,'K',4X,'QY',5X,'C(X,QY)',5X,'CUI',9X,'C/CA',6X,'QY/QT',2
     *X,'DIL FAC'//)
      DO 16 K=1,NQ
      QY(K)=(K-1)*DELQ
      IF (QY(K).GT.QT) QY(K)=QT
      DP1=(QCP1-QY(K))/QT
      DP2=(QCP2-QY(K))/QT
      DP3=(QCP1+QY(K))/QT
      DP4=(QCP2+QY(K))/QT
      SUM1=0.0
      SUM2=0.0
```

```
      DO 30 NN=1,9
      N=NN-1
      T1=DERF((DP2+2.0*N)/PHD2)
      T2=DERF((DP1+2.0*N)/PHD2)
      T3=DERF((DP4+2.0*N)/PHD2)
      T4=DERF((DP3+2.0*N)/PHD2)
30    SUM1=SUM1+T1-T2+T3-T4
      DO 32 N=1,8
      T5=DERF((DP2-2.0*N)/PHD2)
      T6=DERF((DP1-2.0*N)/PHD2)
      T7=DERF((DP4-2.0*N)/PHD2)
      T8=DERF((DP3-2.0*N)/PHD2)
32    SUM2=SUM2+T5-T6+T7-T8
      C(I,K)=CRPX*(SUM1+SUM2)+CBKX
C
C  CALCULATE UN-IONIZED AMMONIA CONCENTRATIONS*  OPTIONAL *
C
      IF(AMONIA.LE.0) GO TO 15
      PKA=0.09018+2729.92/(TMP+273.2)
      PF=PKA-PH
      PCTU=1./(1.+10.**PF)
      CUI(I,K)=C(I,K)*PCTU
15    CONTINUE
      GOTO 16
      NQQ=K
      GO TO 18
16    CONTINUE
      NQQ=NQ
18    CONTINUE
C
C  PRINT OUTPUT
C
      DO 14 K=1,NQ
      CNET=C(I,K)-CBKX
      RC=CNET/CA
      IF(CNET.LE.0.000009) CNET=-CEFL
      DIL=CEFL/CNET
      RQ=QY(K)/QT
      IF(AMONIA.LE.0) CUI(I,K)=0.0
      WRITE(6,25) K,QY(K),C(I,K),CUI(I,K),RC,RQ,DIL
      WRITE(7,25)K,QY(K),C(I,K),CUI(I,K),RC,RQ,DIL
25    FORMAT(3X,I2,F8.2,2X,4(F9.4,2X,F9.1))
14    CONTINUE
      WRITE(5,10101)CHAR(26)
      WRITE(6,10101)CHAR(26)
      WRITE(7,10101)CHAR(26)
10101 FORMAT(1X,A,\)
      CLOSE(5)
      CLOSE(6)
      CLOSE(7)
      CALL CLRSCN
      WRITE(*,1324)
1324  FORMAT(/////'    THE OUTPUT FILE FOR MIXCADIF IS'//'    " CADOUT.D
     *AT "')
      STOP
      END
C
```

```
C
C
      FUNCTION DERF(X)
      REAL*8 X,XX,A1,A2,A3,A4,A5,T,P,AA,DERF,SX
      A1=.254829592
      A2=-.284496736
      A3=1.421413741
      A4=-1.453152027
      A5=1.061405429
      P=.3275911
      XX=DABS(X)
      IF(XX.LT.10.)GO TO 800
      DERF=1.
      GO TO 801
800   T=1./(1.+P*XX)
      AA=T*(A1+T*(A2+T*(A3+T*(A4+T*A5))))
      DERF=1.-AA*DEXP(-XX*XX)
801   IF(X.LT.0)DERF=-DERF
      RETURN
      END
C
C
C
      SUBROUTINE SETUP
      DIMENSION RKS(20),BS(20),ZAV(20),VAV(20),X(20),DY(15)
      CHARACTER*80 TITLE
      OPEN(7,FILE='PINCAL.DAT',STATUS='OLD')
      OPEN(8,FILE='PINCAD.DAT',STATUS='NEW')
      READ(7,1)TITLE
      WRITE(8,1)TITLE
1     FORMAT(A)
      READ(7,919)QRS,BP,HP,UP,THETA
      WRITE(8,919)QRS,BP,HP,UP,THETA
919   FORMAT(2X,F9.2,2X,F5.3,2X,F5.3,2X,F5.3,2X,F6.3)
      READ(7,920)QRUP,QEFL,CEFL,CBKG,TMP
      WRITE(8,920)QRUP,QEFL,CEFL,CBKG,TMP
920   FORMAT(2X,F9.2,2X,F9.2,2X,F10.3,2X,F10.3,2X,F6.1)
      READ(7,*)NTR,NYZ,QCP
C
C
C
      DO 2 I=1,NTR
      READ(7,*)X(I),BS(I),ZAV(I),VAV(I)
2     CONTINUE
      CALL CLRSCN
      WRITE(*,4008)
4008  FORMAT('     HYDRODYNAMIC DATA ENTRY AREA'/'      *****************
     *******************')
      WRITE(*,3)BP,HP,UP
3     FORMAT(////'   THE EXPONENTS FOR THE LEOPOLD-MADDOCK EQNS ARE'/
     *'  WIDTH EXP: ',F5.3/'  DEPTH EXP: ',F5.3/'  VEL.  EXP: ',F5.3)
      WRITE(*,4)
4     FORMAT(/'   DO YOU WISH TO CHANGE THEM?   YES=1  NO=0')
      READ(*,*)ICH
11    IF(ICH.EQ.1)THEN
        WRITE(*,5)
5       FORMAT(/'  WIDTH EXP=  '\)
```

```
        READ(*,*)BP
        WRITE(*,6)
6       FORMAT(/'  DEPTH EXP=  '\)
        READ(*,*)HP
        WRITE(*,7)
7       FORMAT(/'  VEL. EXP=   '\)
        READ(*,*)UP
      ENDIF
      TOT=BP+HP+UP
      IF(TOT.NE.1.)THEN
         WRITE(*,10)
10       FORMAT('     THE EXPONENTS MUST SUM TO 1.0'/'  RE-ENTER THEM')
         GO TO 11
      ENDIF
      CALL CLRSCN
      WRITE(*,4000)
4000  FORMAT('       ENTRY AREA FOR DESIGN PARAMETERS'/'       *********
     ***************************')
      WRITE(*,8)QRUP,QEFL
8     FORMAT(////'    RIVER FLOW RATE ABOVE OUTFALL=',F10.2/'   OUTFALL
     *FLOW RATE=       ',F10.2//'   DO YOU WISH TO CHANGE EITHER?  YES=1
     *  NO=0  '\)
      READ(*,*)IC
      IF(IC.EQ.1)THEN
        WRITE(*,9)
9       FORMAT('   RIVER FLOW RATE=  '\)
        READ(*,*)QRUP
        WRITE(*,12)
12      FORMAT('   OUTFALL FLOW RATE=  '\)
        READ(*,*)QEFL
        QRS=QRUP+QEFL
      ENDIF
      CALL CLRSCN
C
C
      WRITE(*,1110)
1110  FORMAT(////'    ENTER DIFFUSER OUTFALL LOCATION'/'    IN METERS FR
     *OM BANK')
      WRITE(*,1011)
1011  FORMAT(/'   INPUT DISTANCE FORM REF. BANK OF PROXIMAL END : '\)
      READ(*,*)YOUT1
      WRITE(*,1012)
1012  FORMAT(/'   INPUT DISTANCE FROM REF. BANK OF DISTAL END : '\)
      READ(*,*)YOUT2
      WRITE(*,1013)
1013  FORMAT(/'   INPUT NUMBER OF PORTS ON DIFFUSER : '\)
      READ(*,*)NOUT
      OPEN(9,FILE='SCALE.DAT',STATUS='OLD')
      READ(9,*)(DY(I),I=1,11)
      CLOSE(9)
      IG=0
9097  IG=IG+1
      IF(YOUT1.LE.DY(IG))THEN
        A=DY(IG)-YOUT1
        DELY=DY(IG)-DY(IG-1)
        A1=FLOAT(IG-1)/10.
        QCP1=(A1-.1*(A/DELY))
```

```
      QCP1=QCP1*QRS
    ELSE
      GO TO 9097
    ENDIF
    IG=0
9098 IG=IG+1
    IF(YOUT2.LE.DY(IG))THEN
      A=DY(IG)-YOUT2
      DELY=DY(IG)-DY(IG-1)
      A1=FLOAT(IG-1)/10.
      QCP2=(A1-.1*(A/DELY))
      QCP2=QCP2*QRS
    ELSE
      GO TO 9098
    ENDIF
C
    WRITE(8,661)NTR,NYZ,NOUT,QCP1,QCP2
661 FORMAT(2X,I2,2X,I2,2X,I4,2X,F8.2,2X,F8.2)
    DO 662 I=1,NTR
    WRITE(8,*)X(I),BS(I),ZAV(I),VAV(I)
662 CONTINUE
C
    CALL CLRSCN
    WRITE(*,4002)
4002 FORMAT('     CONCENTRATION VALUE ENTRY AREA'/'    ****************
   *******************')
    WRITE(*,28)CEFL
28  FORMAT(/'    THE EFFLUENT CONCENTRATION IS :',F10.2,/'    DO WISH
   *TO CHANGE IT?  YES=1  NO=0  '\)
    READ(*,*)IC
    IF(IC.EQ.1)THEN
      WRITE(*,30)
30    FORMAT(/'   THE NEW EFFLUENT CONC. =  '\)
      READ(*,*)CEFL
    ENDIF
    WRITE(*,31)CBKG
31  FORMAT(/'     THE BACKGROUND CONCENTRATION IS :',F10.2,/'  DO YOU
   *WISH TO CHANGE IT?  YES=1  NO =0  '\)
    READ(*,*)IC
    IF(IC.EQ.1)THEN
      WRITE(*,32)
32    FORMAT(/'   ENTER NEW BACKGROUND CONC.:  '\)
      READ(*,*)CBKG
    ENDIF
    CALL CLRSCN
    WRITE(*,4003)
4003 FORMAT('      DECAY RATE ENTRY AREA'/'       ********************
   ********')
C
    WRITE(*,20)
20  FORMAT(/'    ENTER A DECAY RATE FOR THE RIVER BACKGROUND: '\)
    READ(*,*)RBK
    WRITE(*,21)
21  FORMAT(/'    AT WHAT TEMPERATURE IS THIS RATE KNOWN? IN C : '\)
    READ(*,*)TEMP
    WRITE(*,22)
22  FORMAT(/'    WHAT IS THE RIVER TEMPERATURE? IN C :  '\)
```

```
      READ(*,*)TMP
C
      WRITE(*,50)
50    FORMAT(/'    DO YOU WISH TO CONSIDER AMMONIA?  YES=1  NO=0  '\)
      READ(*,*)IAM
      IF(IAM.EQ.1)THEN
        WRITE(*,51)
51      FORMAT(/'   ENTER PH  '\)
        READ(*,*)PH
      ELSE
        PH=7.0
      ENDIF
C
      OPEN(7,FILE='PPINCAD.DAT',STATUS='NEW')
      WRITE(7,1)TITLE
      WRITE(7,111)QRS,BP,HP,UP,THETA,TEMP,RBK
111   FORMAT(2X,F9.2,3(2X,F5.3),2X,F5.3,2X,F5.2,2X,F10.8)
      WRITE(7,112)QRUP,QEFL,CEFL,CBKG,TMP
112   FORMAT(2X,F9.2,2X,F8.2,2X,F8.2,2X,F8.2,2X,F5.2)
      WRITE(7,113)NTR,NYZ,NOUT,QCP1,QCP2,YOUT1,YOUT2
113   FORMAT(2X,I2,2X,I3,2X,I3,2X,F8.2,2X,F8.2,2X,F8.2,2X,F8.2)
      DO 4033 I=1,NTR
      WRITE(7,*)X(I),BS(I),ZAV(I),VAV(I)
4033  CONTINUE
      WRITE(7,*)IAM,PH
      WRITE(7,4007)CHAR(26)
4007  FORMAT(1X,A)
      CLOSE(7)
      RETURN
      END
C
C
C
      SUBROUTINE CLRSCN
      WRITE(*,101)CHAR(27),'[2J'
101   FORMAT(1X,A,A\)
      RETURN
      END
```

```
$DEBUG
C************************************************************************
C                                                                       *
C      PROGRAM CONMIX.FOR                                               *
C      THIS PROGRAM PLOTS THE OUTPUTS FROM MODELS MIXCALBN              *
C      AND MIXCADIF. IT PRODUCES THREE TYPES OF PLOTS.                  *
C      1.  LATERAL CONCENTRATION PLOTS AT EACH TRANSECT                 *
C      2.  A TWO DIMENSIONAL CONTOUR PLOT                               *
C      3.  A THREE DIMENSIONAL MESH PLOT                                *
C                                                                       *
C      WRITTEN BY R. JARVIS                                             *
C                                                                       *
C     GORE & STORRIE  1986                                              *
C************************************************************************
      COMMON/AA/ JK
      COMMON/B/ CC(50,50)
      COMMON/L/ XG(50),C(10,50),TITLE
      COMMON/PLA/ XH(150),DLX(50),ZLEV(10)
      COMMON/PASS/ XDX(10),BS(10),HS(10),US(10),QRS,QRUP,QEFL,CEFL,CBKG
     *,QCP,POLLU,ICAL,NOUT,QCP1,QCP2,YOUT1,YOUT2,YOUT
      INTEGER*2 LWGT(10),KNXT(2000),LDIG(10),ICOL,IROW,NX,NY,NARC
     1,NDIV,NLEV,NPTS,NRNG
      CHARACTER*80 TITLE
      CHARACTER*20 FILIN
      CHARACTER*30 POLLU
C
      NLEV=10
      NLEVL=NLEV
      ICOL=50
      IROW=50
C
      WRITE(*,6777)
6777  FORMAT(//'    PLOT THE FOLLOWING TYPE OF PLOT   1=YES   0=NO'/)
      WRITE(*,6778)
6778  FORMAT(/'       CROSS STREAM CONCENTRATION PROFILES:  '\)
      READ(*,*)ILAT
      WRITE(*,6779)
6779  FORMAT(/'       2 DIMENSIONAL CONTOUR PLOT:  '\)
      READ(*,*)I2D
      WRITE(*,6780)
6780  FORMAT(/'       3 DIMENSIONAL MESH PLOT:  '\)
      READ(*,*)I3D
C
C     READ PLCALPC
C
      OPEN(5,FILE='PLTPRED',STATUS='OLD')
      READ(5,*)ICAL
      READ(5,112)TITLE
112   FORMAT(A)
      READ(5,*)NTR
      READ(5,*)NYZ
      DO 606 I=1,NTR
      READ(5,*)II,XG(I)
606   CONTINUE
      NTR2=2*NTR
      DO 7779 II=1,NTR2
      READ(5,*)ID,DUMMY
```

```
7779  CONTINUE
      XHIGH=XG(NTR)
      DO 900 J=1,NTR
      DO 905 I=1,11
      READ(5,*)II,F,C(J,I)
905   CONTINUE
900   CONTINUE
      CLOSE(5)
C
C     READ PINCAL.DAT FOR BASIC RIVER INFORMATION
C
      IF(ICAL.EQ.1)OPEN(5,FILE='PPINPRE.DAT',STATUS='OLD')
      IF(ICAL.EQ.2)OPEN(5,FILE='PPINCAD.DAT',STATUS='OLD')
      READ(5,112)DTITLE
      READ(5,*)QRS,BEX,DEX,VEX,TEMC
      READ(5,*)QRUP,QEFL,CEFL,CBKG
      IF(ICAL.EQ.1)READ(5,*)NNTR,NNYZ,QCP,YOUT
      IF(ICAL.EQ.2)READ(5,*)NNTR,NNYZ,NOUT,QCP1,QCP2,YOUT1,YOUT2
      DO 7336 I=1,NNTR
      READ(5,*)XDX(I),BS(I),HS(I),US(I)
7336  CONTINUE
      CLOSE(5)
C
      WRITE(*,1011)
1011  FORMAT(//'    ENTER POLLUTANT NAME (30 LETTERS MAX) : '\)
      READ(*,112)POLLU
C
      DLX(1)=XG(1)
      DO 502 J=2,NTR
      DLX(J)=XG(J)-XG(J-1)
502   CONTINUE
      NTRP1=NTR+1
      SCALE=XHIGH/50.
      DO 3 I=1,50
      XH(I)=FLOAT(I)*SCALE
3     CONTINUE
      I=1
      DO 501 J=1,50
      IF(XH(J).GT.XG(I))I=I+1
      IF(I.EQ.NTRP1) GO TO 501
      A=XG(I)-XH(J)
      B=DLX(I)-A
      DO 500 K=1,11
      IF(I.EQ.1)THEN
      CC(J,K)=0.
      ELSE
      CC(J,K)=(B*C(I,K)+A*C(I-1,K))/DLX(I)
      ENDIF
500   CONTINUE
501   CONTINUE
C
      WRITE(*,30)
30    FORMAT(//' PLOT LOCATION 1=SCREEN 2=PLOTTER 3=PRINTER : '\)
      READ(*,*)JK
      IF(JK.EQ.1)CALL PLOTS(0,0,99)
      IF(JK.EQ.1)CALL FACTOR(.5)
      IF(JK.EQ.2)CALL PLOTS(0,9600,80)
```

```
      IF(JK.EQ.3)CALL PLOTS(0,0,11)
      IF(JK.NE.2.AND.JK.NE.1.AND.JK.NE.3)GO TO 35
      CALL SIMPLX
C
      IF(ILAT.EQ.1)THEN
       CALL TRANS(NTR)
       CALL PLOT(0.,0.,-999)
      ELSE
       CONTINUE
      ENDIF
      IF(I3D.EQ.1)THEN
       CALL THREED(NTR)
       CALL PLOT(0.,0.,-999)
      ELSE
       CONTINUE
      ENDIF
      IF(I2D.EQ.1)CALL TWOD(NTR,XHIGH)
      CALL PLOT(0.,0.,999)
35    STOP
      END
C
C     SUBROUTINE TWOD PLOTS THE TWO DIMENSIONAL CONTOUR PLOT
C
      SUBROUTINE TWOD(NTR,XHIGH)
      COMMON/AA/ JK
      COMMON/A/ X(3000),Y(3000)
      COMMON/D/ Z(50,50),ZZ(3000)
      COMMON/B/ CC(50,50)
      COMMON/L/ XG(50),C(10,50),TITLE
      COMMON/KKL/ ZPIJ(2000),DLX(50),ZLEV(10)
      COMMON/PASS/ XDX(10),BS(10),HS(10),US(10),QRS,QRUP,QEFL,CEFL,CBKG
     *,QCP,POLLU,ICAL,NOUT,QCP1,QCP2,YOUT1,YOUT2,YOUT
      CHARACTER*30 SNAME,POLLU
      CHARACTER*80 TITLE
      INTEGER*2 LWGT(10),KNXT(2000),LDIG(10),ICOL,IROW,NX,NY,
     1NARC,NDIV,NPTS,NRNG
      DATA XLPLOT/0./,YLPLOT/0./,XHPLOT/9./,YHPLOT/3./
      DATA XLOW/0./,YLOW/0./,YHIGH/100./
      DATA CAY/5./,NRNG/2/,HGT/.05/,NDIV/1/,NARC/4/,NSM/1/
      DATA XMAX/10./,YMAX/7.5/
C
      NLEV=10
      NLEVL=NLEV
      ICOL=50
      IROW=50
      NXL=50
      CMIN=99999.0
      CMAX=0.
      DO 99 I=1,NXL
      DO 99 J=1,11
      IF(CC(I,J).LT.CMIN)CMIN=CC(I,J)
      IF(CC(I,J).GT.CMAX)CMAX=CC(I,J)
99    CONTINUE
      IF(CMAX.LT.1)LGO=3
      IF(CMAX.GT.1)LGO=2
      IF(CMAX.GT.10)LGO=1
      DO 98 I=1,10
```

```
      LDIG(I)=LGO
98    CONTINUE
      LWGT(1)=101
      LWGT(2)=201
      LWGT(3)=301
      LWGT(4)=401
      LWGT(5)=501
      LWGT(6)=601
      LWGT(7)=701
      LWGT(8)=801
      LWGT(9)=101
      CR=CMAX-CMIN
      ZLEV(1)=CR/10.+CMIN
      ZLEV(2)=2.*CR/10.+CMIN
      ZLEV(3)=3.*CR/10.+CMIN
      ZLEV(4)=4.*CR/10.+CMIN
      ZLEV(5)=5.*CR/10.+CMIN
      ZLEV(6)=6.*CR/10.+CMIN
      ZLEV(7)=7.*CR/10.+CMIN
      ZLEV(8)=8.*CR/10.+CMIN
      ZLEV(9)=9.*CR/10.+CMIN
      ZLEV(10)=CMAX
      DO 801 L=1,2000
      ZPIJ(L)=0.
      KNXT(L)=0
      X(L)=0.
      Y(L)=0.
      ZZ(L)=0.
801   CONTINUE
      CALL PLOT(0.5,0.7,-3)
      CALL SIMPLX
      IF(JK.EQ.1)CALL FACTOR(.8)
      K=0
      NX=50
      NXL=NX
      NY=11
      NPTS=NX*11
      DX=(XHIGH-XLOW)/FLOAT(NX-1)
      DY=(YHIGH-YLOW)/FLOAT(NY-1)
      DO 10 I=1,NXL
      DO 11 J=1,11
      K=K+1
      X(K)=FLOAT(I-1)*DX
      Y(K)=FLOAT(J-1)*DY
      ZZ(K)=CC(I,J)
      Z(I,J)=0.
11    CONTINUE
10    CONTINUE
      CALL ZGRID(Z,IROW,ICOL,NY,NX,XLOW,YLOW,XHIGH,YHIGH,X,Y,ZZ,
     1NPTS,CAY,NRNG,ZPIJ,KNXT)
      XFACT=(XHIGH-XLOW)/(XHPLOT-XLPLOT)
      YFACT=(YHIGH-YLOW)/(YHPLOT-YLPLOT)
      CALL OFFSET(XLOW,XFACT,YLOW,YFACT)
      CALL PLOT(XLOW,YLOW,13)
      CALL PLOT(XHIGH,YLOW,12)
      CALL PLOT(XHIGH,YHIGH,12)
      CALL PLOT(XLOW,YHIGH,12)
```

```
      CALL PLOT(XLOW,YLOW,12)
      TICKY=5.
      TICKX=5.
      NYP=NY+1
      NXP=NX+1
      DELX=(XHIGH-XLOW)/FLOAT(NX)
      DELY=(YHIGH-YLOW)/FLOAT(NY)
      XGO=XG(NTR)/9.
      CALL STAXIS(.07,.1,.01,.03,2)
      CALL AXIS(0.,0.,'METERS DOWNSTREAM FROM SOURCE',-29,9.,0.,0.,XGO)
      CALL PLOT(XLOW,YLOW,13)
      CALL STDASH(.05,.05)
      DO 709 I=1,9
      YY=FLOAT(I)*.3
      CALL PLOT(-.1,YY,3)
      CALL PLOTD(9.+.1,YY,2)
 709  CONTINUE
      CALL PLOT(XHIGH,YLOW,13)
      DO 711 I=1,11
      YYY=FLOAT(I-1)/10.
      YY=YYY*3.-.11
      CALL NUMBER(-.18,YY,.07,YYY,0.,1)
 711  CONTINUE
      DO 6067 I=1,NTR
      CALL PLOT(XG(I),YLOW,13)
      TICKT=13.
      CALL PLOT(XG(I),YHIGH+TICKT,12)
      CALL WHERE(XLOC,YLOC,FUD)
      TNUM=FLOAT(I)
      CALL NUMBER(XLOC-.03,YLOC+.05,.075,TNUM,0.,-1)
6067  CONTINUE
      CALL PLOT(-0.5,-0.5,-3)
      CALL SYMBOL(.25,1.5,.10,'FLOW FRACTION',90.,13)
      CALL PLOT(0.5,0.5,-3)
      CALL ZCSEG(Z,IROW,ICOL,NY,NX,XLPLOT,YLPLOT,XHPLOT,YHPLOT
     1,ZLEV,LDIG,LWGT,NLEV,HGT,NDIV,NARC)
 35   CONTINUE
C
C
      CALL COLOR(0,IERR)
      IF(ICAL.EQ.1)THEN
        QPLOT=(QCP/QRS)*3.
        CALL SYMBOL(0.,QPLOT,.1,1,0.,-1)
      ELSE
        QPLOT1=(QCP1/QRS)*3.
        QPLOT2=(QCP2/QRS)*3.
        CALL SYMBOL(0.,QPLOT1,.1,1,0.,-1)
        CALL SYMBOL(0.,QPLOT2,.1,1,0.,-1)
      ENDIF
C
C
C
C
      CALL SYMBOL(2.75,3.6,.09,'TRANSECT NUMBER',0.,15)
      CALL SYMBOL(1.0,6.0,.15,TITLE,0.,80)
      CALL SYMBOL(1.0,5.7,.12,'POLLUTANT:',0.,10)
      CALL SYMBOL(5.0,5.7,.12,POLLU,0.,30)
```

```
      CALL SYMBOL(1.0,5.5,.12,'RIVER FLOW RATE ABOVE OUTFALL : ',0.,32)
      CALL NUMBER(5.0,5.5,.12,QRUP,0.,2)
      CALL SYMBOL(6.25,5.5,.12,'CMS',0.,3)
      CALL SYMBOL(1.0,5.3,.12,'EFFLUENT FLOW RATE : ',0.,21)
      CALL NUMBER(5.0,5.3,.12,QEFL,0.,2)
      CALL SYMBOL(6.25,5.3,.12,'CMS',0.,3)
      CALL SYMBOL(1.0,5.1,.12,'EFFLUENT CONCENTRATION : ',0.,25)
      CALL NUMBER(5.0,5.1,.12,CEFL,0.,2)
      CALL SYMBOL(1.0,4.9,.12,'BACKGROUND CONCENTRATION : ',0.,27)
      CALL NUMBER(5.0,4.9,.12,CBKG,0.,2)
      IF(ICAL.EQ.1)THEN
        CALL SYMBOL(1.0,4.7,.12,'PIPE OUTFALL LOCATION : ',0.,24)
        CALL NUMBER(5.0,4.7,.12,YOUT,0.,2)
        CALL SYMBOL(6.0,4.7,.12,'  METERS FROM BANK',0.,18)
        CALL SYMBOL(1.0,4.5,.12,'OUTFALL LOCATION MARKED AS : ',0.,29)
        CALL SYMBOL(5.20,4.5,.09,1,0.,-1)
      ENDIF
      IF(ICAL.EQ.2)THEN
        CALL SYMBOL(1.0,4.7,.12,'DIFFUSER OUTFALL LOCATION : ',0.,28)
        CALL NUMBER(5.0,4.7,.12,YOUT1,0.,2)
        CALL NUMBER(6.5,4.7,.12,YOUT2,0.,2)
        CALL SYMBOL(6.0,4.7,.12,'TO        METERS FROM BANK',0.,26)
        CALL SYMBOL(1.0,4.5,.12,'NUMBER OF DIFFUSER PORTS : ',0.,27)
        POUT=FLOAT(NOUT)
        CALL NUMBER(5.0,4.5,.12,POUT,0.,0)
        CALL SYMBOL(1.0,4.3,.12,'DIFFUSER ENDS MARKED AS : ',0.,26)
        CALL SYMBOL(5.0,4.3,.12,1,0.,-1)
      ENDIF
      RETURN
      END
C
C     SUBROUTINE TRANS PLOTS CROSS STREAM CONCENTRATION PROFILES
C
      SUBROUTINE TRANS(NTR)
      COMMON/AA/ JK
      COMMON/L/ XG(50),C(10,50),TITLE
      COMMON/JJ/ CSAV(50),CSC(4),D(50)
      COMMON/PASS/ XDX(10),BS(10),HS(10),US(10),QRS,QRUP,QEFL,CEFL,CBKG
     *,QCP,POLLU,ICAL,NOUT,QCP1,QCP2,YOUT1,YOUT2,YOUT
      CHARACTER*40 SNAME
      CHARACTER*30 POLLU
      CHARACTER*80 TITLE
      NXL=50
C
      CALL COLOR(0,IERR)
      CALL PLOT(1.3,2.4,-3)
      IF(JK.EQ.2)CALL FACTOR(.75)
      IF(JK.EQ.1)CALL FACTOR(.6)
      IF(JK.EQ.3)CALL FACTOR(.75)
      CALL SYMBOL(1.0,6.0,.15,TITLE,0.,80)
      CALL SYMBOL(1.0,5.7,.12,'POLLUTANT:',0.,10)
      CALL SYMBOL(5.0,5.7,.12,POLLU,0.,30)
      CALL SYMBOL(1.0,5.5,.12,'RIVER FLOW RATE ABOVE OUTFALL : ',0.,32)
      CALL NUMBER(5.0,5.5,.12,QRUP,0.,2)
      CALL SYMBOL(6.25,5.5,.12,'CMS',0.,3)
      CALL SYMBOL(1.0,5.3,.12,'EFFLUENT FLOW RATE : ',0.,21)
      CALL NUMBER(5.0,5.3,.12,QEFL,0.,2)
```

```
      CALL SYMBOL(6.25,5.3,.12,'CMS',0.,3)
      CALL SYMBOL(1.0,5.1,.12,'EFFLUENT CONCENTRATION : ',0.,25)
      CALL NUMBER(5.0,5.1,.12,CEFL,0.,2)
      CALL SYMBOL(1.0,4.9,.12,'BACKGROUND CONCENTRATION : ',0.,27)
      CALL NUMBER(5.0,4.9,.12,CBKG,0.,2)
      IF(ICAL.EQ.1)THEN
        CALL SYMBOL(1.0,4.7,.12,'PIPE OUTFALL LOCATION : ',0.,24)
        CALL NUMBER(5.0,4.7,.12,YOUT,0.,2)
        CALL SYMBOL(6.0,4.7,.12,'  METERS FROM BANK',0.,18)
      ENDIF
      IF(ICAL.EQ.2)THEN
        CALL SYMBOL(1.0,4.7,.12,'DIFFUSER OUTFALL LOCATION : ',0.,28)
        CALL NUMBER(5.0,4.7,.12,YOUT1,0.,2)
        CALL NUMBER(6.5,4.7,.12,YOUT2,0.,2)
        CALL SYMBOL(6.0,4.7,.12,'TO            METERS FROM BANK',0.,31)
        CALL SYMBOL(1.0,4.5,.12,'NUMBER OF DIFFUSER PORTS : ',0.,27)
        POUT=FLOAT(NOUT)
        CALL NUMBER(5.0,4.5,.12,POUT,0.,0)
      ENDIF
      CALL PLOT(-1.,-2.4,-3)
C
      IF(JK.EQ.2)CALL FACTOR(.3)
      IF(JK.EQ.1)CALL FACTOR(.2)
      IF(JK.EQ.3)CALL FACTOR(.3)
      SCA=10.
      CMAXX=0.
      DO 600 I=1,NTR
      DO 601 J=1,11
      IF(C(I,J).GT.CMAXX)CMAXX=C(I,J)
601   CONTINUE
600   CONTINUE
      CSC(1)=-1.*CMAXX/3.
      CSC(2)=CMAXX
      CALL PLOT(0.,0.,-3)
      DO 700 I=1,NTR
      DIST=XG(I)
      IF(I.GT.1)CALL PLOT(-XOR,-YOR,-3)
      IF(I.GE.1.AND.I.LE.4)YOR=12.
      IF(I.GE.5.AND.I.LE.8)YOR=3.
      IF(I.EQ.1.OR.I.EQ.5)XOR=1.
      IF(I.EQ.2.OR.I.EQ.6)XOR=9.
      IF(I.EQ.3.OR.I.EQ.7)XOR=17.
      IF(I.EQ.4.OR.I.EQ.8)XOR=25.
      CALL PLOT(XOR,YOR,-3)
      DO 500 J=1,11
      CSAV(J)=C(I,J)
      D(J)=FLOAT(J-1)*SCA
500   CONTINUE
      CALL SCALE(CSC,5.,2,1)
      CSAV(12)=CSC(3)
      CSAV(13)=CSC(4)
      CALL SCALE(D,5.,11,1)
      CALL STAXIS(.2,.3,.005,.1,1)
      CALL AXIS(0.,0.,'PERCENT FLOW',-12,5.,0.,D(12),D(13))
      CALL AXIS(0.,0.,'CONCENTRATION',13,5.,90.,CSAV(12),CSAV(13))
C      CALL COLOR(4,IERR)
      CALL LINE(D,CSAV,11,1,0,0)
```

```
C      CALL COLOR(0,IERR)
      CALL SYMBOL(1.5,.25,.2,'TRANS. #',0.,8)
      TNUM=FLOAT(I)
      CALL NUMBER(3.5,.25,.2,TNUM,0.,-1)
700   CONTINUE
      CALL PLOT(-XOR,-YOR,-3)
      RETURN
      END
C
C     SUBROUTINE THREED PLOTS THREE DIMENSIONAL MESH PLOTS
C
      SUBROUTINE THREED(NTR)
      COMMON/AA/ JK
      COMMON/B/ CC(50,50)
      COMMON/L/ XG(50),C(10,50),TITLE
      COMMON/Q/ CCP(50,50)
      COMMON/PASS/ XDX(10),BS(10),HS(10),US(10),QRS,QRUP,QEFL,CEFL,CBKG
     *,QCP,POLLU,ICAL,NOUT,QCP1,QCP2,YOUT1,YOUT2,YOUT
      REAL*8 CT,RQ(21),TMTEMP,TM(6,51),MASK(1000),VERTEX(16)
      CHARACTER*25 XTITLE,YTITLE,ZTITLE
      CHARACTER*30 SNAME,POLLU
      CHARACTER*80 TITLE
      INTEGER*2 NX
      DIMENSION NTM(6)
C
      CMAX=0.
      NX=50
      NXL=NX
      DO 4 I=1,NXL
      DO 3 J=1,11
      IF(C(I,J).GT.CMAX)CMAX=C(I,J)
3     CONTINUE
4     CONTINUE
      IF(CC(20,1).GT.0.)THEN
        DO 553 I=1,NXL
        DO 554 J=1,11
        JJ=12-J
        CCP(I,JJ)=CC(I,J)
554     CONTINUE
553     CONTINUE
        ISI=1
      ELSE
        DO 5540 I=1,NXL
        DO 5530 J=1,11
        CCP(I,J)=CC(I,J)
5530    CONTINUE
5540    CONTINUE
        ISI=0
      ENDIF
      NXSIZE=50
      NYSIZE=50
      AZIMUT=330.
      ELEVAT=30.
      XLPLOT=0.
      YLPLOT=0.
      XHPLOT=10.
      YHPLOT=5.
```

```
      IEDGE=0
      IDIR=3
      IPROJ=0
      IFRAME=1
      ZLOW=1.0E35
      ICUT=0
      ITRIM=0
      CALL SIMPLX
      IF(JK.EQ.2)CALL FACTOR(.75)
      IF(JK.EQ.1)CALL FACTOR(.6)
      IF(JK.EQ.3)CALL FACTOR(.75)
      CALL PLOT(3.0,3.3,-3)
      CALL COLOR(0,IERR)
      CALL SYMBOL(1.0,6.0,.15,TITLE,0.,80)
      CALL SYMBOL(1.0,5.7,.12,'POLLUTANT:',0.,10)
      CALL SYMBOL(5.0,5.7,.12,POLLU,0.,30)
      CALL SYMBOL(1.0,5.5,.12,'RIVER FLOW RATE ABOVE OUTFALL : ',0.,32)
      CALL NUMBER(5.0,5.5,.12,QRUP,0.,2)
      CALL SYMBOL(6.25,5.5,.12,'CMS',0.,3)
      CALL SYMBOL(1.0,5.3,.12,'EFFLUENT FLOW RATE : ',0.,21)
      CALL NUMBER(5.0,5.3,.12,QEFL,0.,2)
      CALL SYMBOL(6.25,5.3,.12,'CMS',0.,3)
      CALL SYMBOL(1.0,5.1,.12,'EFFLUENT CONCENTRATION : ',0.,25)
      CALL NUMBER(5.0,5.1,.12,CEFL,0.,2)
      CALL SYMBOL(1.0,4.9,.12,'BACKGROUND CONCENTRATION : ',0.,27)
      CALL NUMBER(5.0,4.9,.12,CBKG,0.,2)
      IF(ICAL.EQ.1)THEN
        CALL SYMBOL(1.0,4.7,.12,'PIPE OUTFALL LOCATION : ',0.,24)
        CALL NUMBER(5.0,4.7,.12,YOUT,0.,2)
        CALL SYMBOL(6.0,4.7,.12,'  METERS FROM BANK',0.,18)
      ENDIF
      IF(ICAL.EQ.2)THEN
        CALL SYMBOL(1.0,4.7,.12,'DIFFUSER OUTFALL LOCATION : ',0.,28)
        CALL NUMBER(5.0,4.7,.12,YOUT1,0.,2)
        CALL NUMBER(6.5,4.7,.12,YOUT2,0.,2)
        CALL SYMBOL(6.0,4.7,.12,'TO        METERS FROM BANK',0.,26)
        CALL SYMBOL(1.0,4.5,.12,'NUMBER OF DIFFUSER PORTS : ',0.,27)
        POUT=FLOAT(NOUT)
        CALL NUMBER(5.0,4.5,.12,POUT,0.,0)
      ENDIF
      CALL PLOT(-2.,-2.5,-3)
C
      NYZ=11
      CALL MESH(CCP,NXSIZE,NYSIZE,NX,NYZ,AZIMUT,ELEVAT,XLPLOT,YLPLOT,
     1          XHPLOT,YHPLOT,IEDGE,IDIR,IPROJ,IFRAME,ZLOW,ICUT,ITRIM,
     2          MASK,VERTEX)
C
C     SET UP THE AXIS PARAMETERS AND PLOT THE AXES
C
      RNTP=FLOAT(NX)
      RNY=11.
      XMIN=0.
      XMAX=1000.
      CALL P3D2D(1.,1.,0.,XORG,YORG)
      CALL P3D2D(RNTP,1.,0.,XX,YX)
      CALL P3D2D(1.,RNY,0.,XY,YY)
      CALL P3D2D(1.,RNY,CMAX,XZY,YZY)
```

```
XLEN=SQRT((XX-XORG)**2+(YX-YORG)**2)
YLEN=SQRT((XY-XORG)**2+(YY-YORG)**2)
ZLEN=YZY-YY
FACT=180./3.141592654
XANGLE=ATAN2(YX-YORG,XX-XORG)*FACT
YANGLE=ATAN2(YORG-YY,XORG-XY)*FACT
ZANGLE=90.
XDELTA=(XMAX-XMIN)/XLEN
YDELTA=1./YLEN
ZDELTA=CMAX/ZLEN
XTITLE='DISTANCE DOWN STREAM'
NXT=20
YTITLE='FRACTIONAL DISCHARGE'
NYT=20
ZTITLE='CONCENTRATION'
NZT=13
CALL STAXIS(.125,.125,.0625,.0625,1)
CALL AXIS(XORG,YORG,XTITLE,-NXT,XLEN,XANGLE,XMIN,XDELTA)
CALL AXIS(XY,YY,YTITLE,-NYT,YLEN,YANGLE,0.,YDELTA)
CALL AXIS(XY,YY,ZTITLE,NZT,ZLEN,ZANGLE,0.,ZDELTA)
RETURN
END
```

APPENDIX D

OUTPUT FILES FROM MIXING ZONE PROGRAMS

```
MISSISSIPPI RIVER
AMMONIA                          .00000  15.00000    .00000    .00000    .00

      TRANSECT  1            200.0 METERS FROM OUTFALL
         PARAMETER 1: AMMONIA
    QRIVER= 2374.020     BACKGROUND CONC.=     .000
    QEFL  =    76.000    EFFLUENT CONCN.=    15.000
    UPSTREAM FLUX=     .00   EFFLUENT FLUX= 1140.00   TOTAL FLUX = 1140
         VELOCITIES SIMULATED FROM RESISTANCE EQN.

   Y       Z      VEL     CONC     SUMA    SUMQ     SUMF    Y/B    QY/QT  C/CAVG

    .00    .00    .00   8.00      .00      .00       .00  .000    .000 16.660 1
  16.67   1.67    .55   6.00    13.92     3.83     26.80  .030    .002 12.495 1
  44.44   8.89   1.69   1.00   160.55   167.80    600.71  .081    .071  2.082
  83.33   7.78   1.54    .50   484.69   691.13    993.21  .151    .291  1.041
 132.22   6.11   1.31    .00   824.23  1175.69   1114.35  .240    .495   .000
 150.00   5.56   1.23    .00   927.98  1307.62   1114.35  .272    .551   .000
 177.78   4.44   1.06    .00  1066.88  1466.71   1114.35  .323    .618   .000
 222.22   3.00    .81    .00  1232.20  1621.59   1114.35  .403    .683   .000
 333.33   2.22    .67    .00  1522.19  1836.22   1114.35  .605    .773   .000
 444.44   4.44   1.06    .00  1892.19  2155.33   1114.35  .806    .908   .000
 551.11   1.11    .42    .00  2188.20  2374.02   1114.35 1.000   1.000   .000
      TRANSECT  1       : VARIANCE FROM DIFFERENT METHODS:
   PARAMETER     VCMAX        VCN         VUF         VCQ          VPQ

        1        162.04     1409.69     3182.71   163469.30     3087.82


    NONDIMENSIONAL VARIANCE      X/B=      .36     X/H=      50.4

 PARAMETER    VCN/BB     VCN/HH     VUF/BB     VUF/HH     VCQ/QQ

      1       .0046     89.419      .0105    201.883      .0290
AMMONIA          .00000  15.00000    .00000    .00000    .00000    .00000
1


      TRANSECT  2            2000.0 METERS FROM OUTFALL
         PARAMETER 1: AMMONIA
    QRIVER= 2374.020     BACKGROUND CONC.=     .000
    QEFL  =    76.000    EFFLUENT CONCN.=    15.000
    UPSTREAM FLUX=     .00   EFFLUENT FLUX= 1140.00   TOTAL FLUX =  1140
         VELOCITIES SIMULATED FROM RESISTANCE EQN.

   Y      Z     VEL    CONC     SUMA     SUMQ     SUMF    Y/B   QY/QT  C/CAVG  C/

    .00   .00    .00   3.00      .00      .00       .00  .000   .000   6.247  6.
  16.67  2.22    .70   2.70    18.50     6.51     18.57  .036   .003   5.623  5.
 100.00  3.56    .97   2.00   259.33   207.63    491.18  .216   .087   4.165  4.
 168.89  5.00   1.21   1.00   554.18   528.89    973.08  .365   .223   2.082  2.
 188.89  5.38   1.27    .50   657.98   657.97   1069.89  .408   .277   1.041  1.
 205.56  5.56   1.30    .00   749.16   775.44   1099.26  .444   .327    .000   .
 228.89  5.56   1.30    .00   878.88   944.39   1099.26  .494   .398    .000   .
 300.00  7.78   1.63    .00  1353.18  1640.13   1099.26  .647   .691    .000   .
 341.11  5.00   1.21    .00  1615.87  2013.72   1099.26  .736   .848    .000   .
```

441.11	2.28	.72	.00	1979.87	2364.94	1099.26	.952	.996	.000	.
463.33	.00	.00	.00	2005.20	2374.02	1099.26	1.000	1.000	.000	.

AVG. CONC. JUST BELOW OUTFALL, CAVG= .480
AVG. CONC. AT THE TRANSECT, CATRN = .463 TOTAL FLUX AT TRANSE
MEAN DEPTH= 4.328 MEAN VELOCITY= 1.184 SHAPE-VELOCITY FACTOR=

TRANSECT 2 : VARIANCE FROM DIFFERENT METHODS:

PARAMETER	VCMAX	VCN	VUF	VCQ	VPQ
1	2366.60	8691.42	13245.78	109118.10	21367.13

NONDIMENSIONAL VARIANCE X/B= 4.32 X/H= 462.1

PARAMETER	VCN/BB	VCN/HH	VUF/BB	VUF/HH	VCQ/QQ	
1	.0405	464.039	.0617	707.199	.0194	
AMMONIA	.00000	15.00000	.00000	.00000	.00000	.0000

1

TRANSECT 3 4500.0 METERS FROM OUTFALL
PARAMETER 1: AMMONIA
QRIVER= 2374.020 BACKGROUND CONC.= .000
QEFL = 76.000 EFFLUENT CONCN.= 15.000
UPSTREAM FLUX= .00 EFFLUENT FLUX= 1140.00 TOTAL FLUX =
VELOCITIES SIMULATED FROM RESISTANCE EQN.

Y	Z	VEL	CONC	SUMA	SUMQ	SUMF	Y/B	QY/QT	C/CAVG	C/C
.00	.00	.00	2.90	.00	.00	.00	.000	.000	6.039	9.9
61.11	1.67	1.24	2.40	51.03	31.55	83.60	.090	.013	4.998	8.2
111.11	2.22	1.50	2.00	148.28	164.43	375.94	.164	.069	4.165	6.8
127.78	2.22	1.50	1.70	185.28	219.80	478.38	.189	.093	3.540	5.8
142.22	2.22	1.50	1.10	217.34	267.77	545.53	.210	.113	2.291	3.7
205.56	1.33	1.06	.50	329.77	411.56	660.56	.303	.173	1.041	1.7
283.33	1.67	1.24	.00	446.42	545.60	694.07	.418	.230	.000	.0
311.11	2.67	1.69	.00	506.71	633.90	694.07	.459	.267	.000	.0
381.11	2.67	1.69	.00	693.61	950.37	694.07	.562	.400	.000	.0
433.33	3.89	2.18	.00	864.89	1281.99	694.07	.639	.540	.000	.0
477.78	3.33	1.96	.00	1025.35	1614.33	694.07	.705	.680	.000	.0
527.78	3.67	2.10	.00	1200.35	1969.48	694.07	.779	.830	.000	.0
550.00	2.28	1.52	.00	1266.46	2089.09	694.07	.811	.880	.000	.0
577.78	1.89	1.34	.00	1324.38	2172.11	694.07	.852	.915	.000	.0
662.22	1.67	1.24	.00	1474.68	2365.99	694.07	.977	.997	.000	.0
677.78	.00	.00	.00	1487.67	2374.02	694.07	1.000	1.000	.000	.0

AVG. CONC. JUST BELOW OUTFALL, CAVG= .480
AVG. CONC. AT THE TRANSECT, CATRN = .292 TOTAL FLUX AT TRANSECT=
MEAN DEPTH= 2.195 MEAN VELOCITY= 1.596 SHAPE-VELOCITY FACTOR=

TRANSECT 3 : VARIANCE FROM DIFFERENT METHODS:

PARAMETER	VCMAX	VCN	VUF	VCQ	VPQ
1	2924.33	11368.83	15000.90	45450.23	9116.05

NONDIMENSIONAL VARIANCE X/B= 6.64 X/H= 2050.2

PARAMETER	VCN/BB	VCN/HH	VUF/BB	VUF/HH	VCQ/QQ	
1	.0247	2359.812	.0327	3113.715	.0081	
AMMONIA	.00000	15.00000	.00000	.00000	.00000	.0000

1

TRANSECT 4 10150.0 METERS FROM OUTFALL
PARAMETER 1: AMMONIA
QRIVER= 2374.020 BACKGROUND CONC.= .000
QEFL = 76.000 EFFLUENT CONCN.= 15.000
UPSTREAM FLUX= .00 EFFLUENT FLUX= 1140.00 TOTAL FLUX = 1
VELOCITIES SIMULATED FROM RESISTANCE EQN.

Y	Z	VEL	CONC	SUMA	SUMQ	SUMF	Y/B	QY/QT	C/CAVG	C/CA
.00	.00	.00	2.30	.00	.00	.00	.000	.000	4.790	6.5
26.67	2.89	.66	2.00	38.54	12.69	27.29	.075	.005	4.165	5.6
62.22	3.56	.76	1.60	153.19	93.88	173.43	.175	.040	3.332	4.5
94.44	5.56	1.02	1.10	300.11	224.55	349.83	.266	.095	2.291	3.1
127.78	7.22	1.22	.90	513.15	462.92	588.21	.359	.195	1.874	2.5
150.00	8.11	1.32	.20	683.47	678.52	706.78	.422	.286	.416	.5
222.22	7.78	1.28	.10	1257.26	1422.77	818.42	.625	.599	.208	.2
255.56	8.22	1.33	.00	1523.98	1770.31	835.80	.719	.746	.000	.0
283.33	8.44	1.35	.00	1755.30	2080.03	835.80	.797	.876	.000	.0
344.44	1.89	.50	.00	2070.93	2371.42	835.80	.969	.999	.000	.0
355.56	.00	.00	.00	2081.44	2374.02	835.80	1.000	1.000	.000	.0

AVG. CONC. JUST BELOW OUTFALL, CAVG= .480
AVG. CONC. AT THE TRANSECT, CATRN = .352 TOTAL FLUX AT TRANSECT= 83
MEAN DEPTH= 5.854 MEAN VELOCITY= 1.141 SHAPE-VELOCITY FACTOR=

TRANSECT 4 : VARIANCE FROM DIFFERENT METHODS:

PARAMETER	VCMAX	VCN	VUF	VCQ	VPQ
1	1494.55	6824.84	13716.91	286194.10	21015.44

NONDIMENSIONAL VARIANCE X/B= 28.55 X/H= 1733.9

PARAMETER	VCN/BB	VCN/HH	VUF/BB	VUF/HH	VCQ/QQ	
1	.0540	199.154	.1085	400.270	.0508	
AMMONIA	.00000	15.00000	.00000	.00000	.00000	.00000

1

TRANSECT 5 17450.0 METERS FROM OUTFALL
PARAMETER 1: AMMONIA
QRIVER= 2374.020 BACKGROUND CONC.= .000
QEFL = 76.000 EFFLUENT CONCN.= 15.000

UPSTREAM FLUX= .00 EFFLUENT FLUX= 1140.00 TOTAL FLUX = 1140.
VELOCITIES SIMULATED FROM RESISTANCE EQN.

Y	Z	VEL	CONC	SUMA	SUMQ	SUMF	Y/B	QY/QT	C/CAVG	C/CAT
.00	.00	.00	1.80	.00	.00	.00	.000	.000	3.748	5.16
77.78	3.56	.93	1.30	138.45	64.49	99.97	.104	.027	2.707	3.72
144.44	3.40	.90	1.00	370.43	277.34	344.74	.193	.117	2.082	2.86
233.33	3.35	.89	.80	670.43	547.03	587.46	.311	.230	1.666	2.29
250.00	3.33	.89	.70	726.11	596.74	624.74	.333	.251	1.458	2.00
303.33	3.11	.85	.60	897.83	746.30	721.96	.404	.314	1.249	1.72
338.89	2.22	.68	.30	992.60	818.80	754.58	.452	.345	.625	.86
383.33	2.79	.79	.20	1103.92	900.64	775.04	.511	.379	.416	.57
483.33	3.67	.95	.10	1426.92	1182.00	817.25	.644	.498	.208	.28
550.00	3.33	.89	.00	1660.26	1396.89	827.99	.733	.588	.000	.00
611.11	5.00	1.17	.00	1914.79	1659.14	827.99	.815	.699	.000	.00
727.78	5.00	1.17	.00	2498.14	2341.53	827.99	.970	.986	.000	.00
750.00	.00	.00	.00	2553.69	2374.02	827.99	1.000	1.000	.000	.00

AVG. CONC. JUST BELOW OUTFALL, CAVG= .480
AVG. CONC. AT THE TRANSECT, CATRN = .349 TOTAL FLUX AT TRANSECT=
MEAN DEPTH= 3.405 MEAN VELOCITY= .930 SHAPE-VELOCITY FACTOR=

TRANSECT 5 : VARIANCE FROM DIFFERENT METHODS:

PARAMETER	VCMAX	VCN	VUF	VCQ	VPQ
1	6718.22	38319.33	46227.59	245477.00	33674.34

NONDIMENSIONAL VARIANCE X/B= 23.27 X/H= 5124.9

PARAMETER	VCN/BB	VCN/HH	VUF/BB	VUF/HH	VCQ/QQ
1	.0681	3305.256	.0822	3987.387	.0436

```
 ENTER TITLE OF STUDY
MISSISSIPPI RIVER
  ENTER QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK
2374.02    .05    .50   .45   1.030   20.00   .00
  ENTER DESIGN CASE: QRUP,QEFL,CEFL,CBKG,TMP
 2298.02    76.000     15.00     .00   22.90
  ENTER NTR,NYZ,QCP
   5    10   .0
  ENTER  5 VALUES OF X,BS,HS,US
   1     200.00      551.11      3.97     1.0800
   2    2000.00      463.33      4.33     1.1800
   3    4500.00      677.78      2.19     1.6000
   4   10150.00      355.56      5.85     1.1400
   5   17450.00      750.00      3.40      .9300
  ENTER  5 VALUES OF DECAY
   1 .0000231
   2 .0000231
   3 .0000231
   4 .0000231
   5 .0000231

  ENTER VALUES OF BETA

  TRANSECT   1 :       .0040000
  TRANSECT   2 :       .0017000
  TRANSECT   3 :       .0007800
  TRANSECT   4 :       .0010000
  TRANSECT   5 :       .0007000
  ARE YOU CONSIDERING UN-IONIZED AMMONIA: YES=1   NO=0
  ENTER THE PH OF UN-IONIZED AMMONIA
 THE PH OF UN-IONIZED AMMONIA IS   8.3

    TRANSECT:  1  BETA=  .004000  RKS=  .000023
      X         BW          HW         UW
   200.000   551.110     3.970     1.080
   QY      C(X,QY)      CUI         C/CA        QY/QT       DIL FAC

1        .00     7.0777      .6304   14.7392      .0000         2.12
2     237.40     1.2646      .1126    2.6334      .1000        11.86
3     474.80      .0072      .0006     .0150      .2000      2079.68
4     712.21      .0000      .0000     .0000      .3000        -1.00
5     949.61      .0000      .0000     .0000      .4000        -1.00
6    1187.01      .0000      .0000     .0000      .5000        -1.00
7    1424.41      .0000      .0000     .0000      .6000        -1.00
8    1661.81      .0000      .0000     .0000      .7000        -1.00
9    1899.22      .0000      .0000     .0000      .8000        -1.00
10   2136.62      .0000      .0000     .0000      .9000        -1.00
11   2374.02      .0000      .0000     .0000     1.0000        -1.00

    TRANSECT:  2  BETA=  .001700  RKS=  .000023
      X         BW          HW         UW
  2000.000   511.609     4.131     1.123
   QY      C(X,QY)      CUI         C/CA        QY/QT       DIL FAC

1        .00     3.1833      .2835    6.6291      .0000         4.71
2     237.40     2.1853      .1946    4.5507      .1000         6.86
```

3	474.80	.7069	.0630	1.4722	.2000	21.22
4	712.21	.1078	.0096	.2244	.3000	139.18
5	949.61	.0077	.0007	.0161	.4000	1937.32
6	1187.01	.0003	.0000	.0005	.5000	57222.88
7	1424.41	.0000	.0000	.0000	.6000	-1.00
8	1661.81	.0000	.0000	.0000	.7000	-1.00
9	1899.22	.0000	.0000	.0000	.8000	-1.00
10	2136.62	.0000	.0000	.0000	.9000	-1.00
11	2374.02	.0000	.0000	.0000	1.0000	-1.00

TRANSECT: 3 BETA= .000780 RKS= .000023

X	BW	HW	UW
4500.000	544.357	3.624	1.204

	QY	C(X,QY)	CUI	C/CA	QY/QT	DIL FAC
1	.00	3.1071	.2767	6.4705	.0000	4.83
2	237.40	2.1085	.1878	4.3909	.1000	7.11
3	474.80	.6589	.0587	1.3721	.2000	22.77
4	712.21	.0948	.0084	.1975	.3000	158.19
5	949.61	.0063	.0006	.0131	.4000	2387.14
6	1187.01	.0002	.0000	.0004	.5000	78222.83
7	1424.41	.0000	.0000	.0000	.6000	-1.00
8	1661.81	.0000	.0000	.0000	.7000	-1.00
9	1899.22	.0000	.0000	.0000	.8000	-1.00
10	2136.62	.0000	.0000	.0000	.9000	-1.00
11	2374.02	.0000	.0000	.0000	1.0000	-1.00

TRANSECT: 4 BETA= .001000 RKS= .000023

X	BW	HW	UW
10150.000	528.945	3.839	1.169

	QY	C(X,QY)	CUI	C/CA	QY/QT	DIL FAC
1	.00	1.5899	.1416	3.3109	.0000	9.43
2	237.40	1.3957	.1243	2.9065	.1000	10.75
3	474.80	.9442	.0841	1.9662	.2000	15.89
4	712.21	.4922	.0438	1.0250	.3000	30.48
5	949.61	.1977	.0176	.4118	.4000	75.86
6	1187.01	.0612	.0055	.1275	.5000	245.04
7	1424.41	.0146	.0013	.0304	.6000	1027.14
8	1661.81	.0027	.0002	.0056	.7000	5586.98
9	1899.22	.0004	.0000	.0008	.8000	39434.46
10	2136.62	.0000	.0000	.0001	.9000	359252.00
11	2374.02	.0000	.0000	.0000	1.0000	-1.00

TRANSECT: 5 BETA= .000700 RKS= .000023

X	BW	HW	UW
17450.000	538.916	4.176	1.055

	QY	C(X,QY)	CUI	C/CA	QY/QT	DIL FAC
1	.00	1.2007	.1069	2.5003	.0000	12.49
2	237.40	1.0753	.0958	2.2392	.1000	13.95
3	474.80	.7723	.0688	1.6084	.2000	19.42
4	712.21	.4449	.0396	.9266	.3000	33.71
5	949.61	.2056	.0183	.4281	.4000	72.96
6	1187.01	.0762	.0068	.1587	.5000	196.89
7	1424.41	.0226	.0020	.0472	.6000	662.43
8	1661.81	.0054	.0005	.0112	.7000	2778.83

9	1899.22	.0010	.0001	.0021	.8000	14532.04
10	2136.62	.0002	.0000	.0003	.9000	93644.91
11	2374.02	.0000	.0000	.0001	1.0000	385323.80

```
    ENTER TITLE OF STUDY
MISSISSIPPI RIVER
    ENTER QRS,BPWR,HPWR,UPWR,THETA,TEMPS,RBK
    3100.000    .050    .500   .450    .0300  20.0000    .00
    ENTER DESIGN CASE: QRUP,QEFL,CEFL,CBKG,TMP
    3000.000  100.00     20.00    .00   22.90
   ENTER NTR,NYZ,NOUT,QCP1,QCP2
    5   10   10  1117.73  2188.74
   ENTER NTR VALUES OF X,BS,HS,US
    200.00    551.11   3.97   1.080
   2000.00    463.33   4.33   1.180
   4500.00    677.78   2.19   1.600
  10150.00    355.56   5.85   1.140
  17450.00    750.00   3.40    .930
    .00002310
    .00002310
    .00002310
    .00002310
    .00002310
    1   .0040000
    2   .0017000
    3   .0007800
    4   .0010000
    5   .0007000
   UN-IONIZED AMMONIA:  ENTER 1 FOR YES,  0 FOR NO
 AND ENTER
    PH VALUE ON THE SAME LINE   1    8.30


  MISSISSIPPI RIVER
  UPSTREAM FLOW=3000.000   BACKGROUND CONC.=    .000  DESIGN TEMP= 22.9
  EFFLUENT FLOW= 100.000   EFFLUENT CONC.=   20.00
  DIFFUSER OUTFALL LOCATED BETWEEN1117.73  AND  2188.74


     TRANSECT:  1  BETA=  .004000  RKS=  .000023
       X          BW          HW        UW
    200.000   551.110     3.970     1.080

    K    QY     C(X,QY)     CUI         C/CA      QY/QT  DIL FAC


    1      .00      .0000          .0    .0000          .0  -1.0000
    2  310.00      .0000          .0    .0000          .1  -1.0000
    3  620.00      .0027          .0    .0042          .27426.6480
    4  930.00      .2437          .0    .3778          .3  82.0535
    5 1240.00     1.4340          .1   2.2227          .4  13.9469
    6 1550.00     1.8583          .2   2.8803          .5  10.7628
    7 1860.00     1.8216          .2   2.8235          .6  10.9794
    8 2170.00     1.0171          .1   1.5765          .7  19.6637
    9 2480.00      .0758          .0    .1175          .8 263.7737
   10 2790.00      .0003          .0    .0005          .9*********
   11 3100.00      .0000          .0    .0000         1.0  -1.0000

     TRANSECT:  2  BETA=  .001700  RKS=  .000023
       X          BW          HW        UW
```

2000.000 511.609 4.131 1.467

K	QY	C(X,QY)	CUI	C/CA	QY/QT	DIL FAC
1	.00	.0033	.0	.0051	.0	6073.3723
2	310.00	.0223	.0	.0346	.1	896.9067
3	620.00	.1529	.0	.2369	.2	130.8418
4	930.00	.5593	.0	.8668	.3	35.7622
5	1240.00	1.1763	.1	1.8232	.4	17.0029
6	1550.00	1.5869	.1	2.4598	.5	12.6029
7	1860.00	1.4981	.1	2.3221	.6	13.3499
8	2170.00	.9697	.1	1.5031	.7	20.6245
9	2480.00	.3875	.0	.6006	.8	51.6177
10	2790.00	.0870	.0	.1348	.9	229.9990
11	3100.00	.0201	.0	.0312	1.0	993.4742

TRANSECT: 3 BETA= .000780 RKS= .000023

X	BW	HW	UW
4500.000	544.357	3.624	1.572

K	QY	C(X,QY)	CUI	C/CA	QY/QT	DIL FAC
1	.00	.0028	.0	.0043	.0	7148.1117
2	310.00	.0204	.0	.0316	.1	981.9149
3	620.00	.1470	.0	.2278	.2	136.0911
4	930.00	.5541	.0	.8589	.3	36.0915
5	1240.00	1.1808	.1	1.8302	.4	16.9382
6	1550.00	1.5975	.1	2.4761	.5	12.5198
7	1860.00	1.5076	.1	2.3367	.6	13.2665
8	2170.00	.9707	.1	1.5046	.7	20.6032
9	2480.00	.3809	.0	.5904	.8	52.5084
10	2790.00	.0823	.0	.1276	.9	242.9518
11	3100.00	.0180	.0	.0279	1.0	1111.1721

TRANSECT: 4 BETA= .001000 RKS= .000023

X	BW	HW	UW
10150.000	528.945	3.839	1.527

K	QY	C(X,QY)	CUI	C/CA	QY/QT	DIL FAC
1	.00	.1221	.0	.1892	.0	163.8056
2	310.00	.1869	.0	.2898	.1	106.9853
3	620.00	.3799	.0	.5888	.2	52.6453
4	930.00	.6720	.1	1.0417	.3	29.7598
5	1240.00	.9724	.1	1.5072	.4	20.5681
6	1550.00	1.1490	.1	1.7809	.5	17.4070
7	1860.00	1.1115	.1	1.7229	.6	17.9929
8	2170.00	.8813	.1	1.3660	.7	22.6935
9	2480.00	.5773	.1	.8948	.8	34.6441
10	2790.00	.3365	.0	.5216	.9	59.4311
11	3100.00	.2472	.0	.3832	1.0	80.9018

TRANSECT: 5 BETA= .000700 RKS= .000023

X	BW	HW	UW

17450.000 538.916 4.176 1.377

K	QY	C(X,QY)	CUI	C/CA	QY/QT	DIL FAC
1	.00	.1670	.0	.2589	.0	119.7269
2	310.00	.2306	.0	.3574	.1	86.7255
3	620.00	.4125	.0	.6393	.2	48.4879
4	930.00	.6736	.1	1.0442	.3	29.6890
5	1240.00	.9306	.1	1.4425	.4	21.4904
6	1550.00	1.0780	.1	1.6709	.5	18.5530
7	1860.00	1.0475	.1	1.6237	.6	19.0926
8	2170.00	.8562	.1	1.3272	.7	23.3582
9	2480.00	.5978	.1	.9266	.8	33.4566
10	2790.00	.3873	.0	.6003	.9	51.6429
11	3100.00	.3076	.0	.4768	1.0	65.0209

```
  ENTER TITLE OF STUDY
MISSISSIPPI RIVER - TEST DATA

  ENTER POLLUTANT NAME
CHLORINE
  ENTER QRS,BPWR,HPWR,UPWR,TEMPS,NTR
    2374.0       .1       .50       .45 22.9   5
  ENTER NTR VALUES OF X,BS,HS,US
     200.0     551.1     3.97    1.080
    2000.0     463.3     4.33    1.180
    4500.0     677.8     2.19    1.600
   10150.0     355.6     5.85    1.140
   17450.0     750.0     3.40     .930
  ENTER NTR VALUES OF BETA
     .00400
     .00170
     .00078
     .00100
     .00070
  ENTER MQ & QRUP VALUES
    QRUP(   1)=  1000.00
    QRUP(   2)=  3000.00
  ENTER MT & TEMP VALUES
    TMP(  1)=  22.0
  ENTER MF & QELF VALUES
    QEFL( 1)= 75.00
  UN-IONIZED AMMONIA: ENTER 1 FOR YES
 0 FOR NO
   AMONIA=0.
  ENTER QCP,CEFL,CBKG,CS,THETA,RBK,XWCP
    .00       20.00       .00       .02     1.10      .00 20000.0
  ENTER NTR VALUES OF RKS
  RKS( 1)= .000023
  RKS( 2)= .000023
  RKS( 3)= .000023
  RKS( 4)= .000023
  RKS( 5)= .000023

      PREDICTIONS OF RUNS FOR MANAGEMENT OPTIONS
MISSISSIPPI RIVER - TEST DATA

  * * RUN NO.:    1
  QEFL=  75.000  QRUP=  1000.000  TEMPR=22.0  PH= 7.0
  CEFL=   20.00  CS=  .02

      X       EY        .0        .1        .2        .3        .4


     200.0    1.602   20.144     3.848      .027      .000      .000
    2000.0     .625    8.991     6.263     2.117      .347      .028
    4500.0     .569    8.707     5.998     1.961      .304      .022
   10150.0     .273    4.345     3.834     2.633     1.408      .586
   17450.0     .329    3.154     2.837     2.064     1.215      .578

     XS (WITH CE)=      -999.0
     MIXING ZONE LENGTH=1029815.5     CONC=      .00
     DIST. TO D/S WPCP= 20000.0     SHORE CONC. AT D/S WPCP=  2.70
```

AVG. CONC. AT D/S WPCP= .79

CRITICAL POINT METHOD RESULTS

QY/QT	XL	CL	CEA	XSCEA
.10	1348.5	6.504	.06	6536.9
.20	7364.9	2.711	.15	19898.0
.30	13483.1	1.461	.27	-999.0
.40	20000.1	.856	.47	-999.0

* * RUN NO.: 2
QEFL= 75.000 QRUP= 3000.000 TEMPR=22.0 PH= 7.0
CEFL= 20.00 CS= .02

X	EY	.0	.1	.2	.3	.4
200.0	2.710	7.245	1.266	.007	.000	.000
2000.0	1.058	3.290	2.248	.717	.107	.007
4500.0	.963	3.243	2.190	.674	.095	.006
10150.0	.461	1.713	1.501	1.010	.522	.207
17450.0	.556	1.359	1.216	.869	.497	.227

XS (WITH CE)= -999.0
MIXING ZONE LENGTH=1085378.6 CONC= .00
DIST. TO D/S WPCP= 20000.0 SHORE CONC. AT D/S WPCP= 1.20
AVG. CONC. AT D/S WPCP= .34

CRITICAL POINT METHOD RESULTS

QY/QT	XL	CL	CEA	XSCEA
.10	1453.5	2.303	.17	7399.9
.20	8428.7	1.015	.39	-999.0
.30	15934.9	.579	.69	-999.0
.40	30085.1	.290	1.38	-999.0

SUMMARY OF RUNS FOR MANAGEMENT OPTIONS
MISSISSIPPI RIVER - TEST DATA

RUN	QEFL	QRUP	TEMP	PH	CAWP	XSCE	QY/QT	CEA	XSCEA	CBKG	CSIJC	CBIOT
1.	75.000	1000.0	22.0	7.0	.787	-999.0	.10	.06	6536.9	.00	.0	.0
							.20	.15	19898.0			
							.30	.27	-999.0			
							.40	.47	-999.0			
2.	75.000	3000.0	22.0	7.0	.341	-999.0	.10	.17	7399.9	.00	.0	.0
							.20	.39	-999.0			
							.30	.69	-999.0			
							.40	1.38	-999.0			